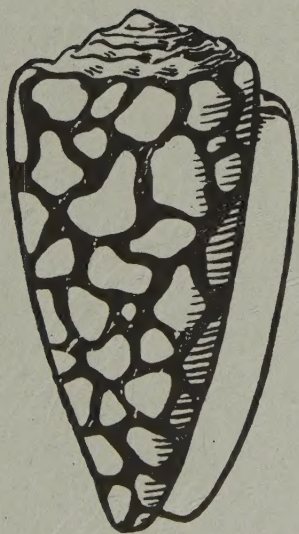


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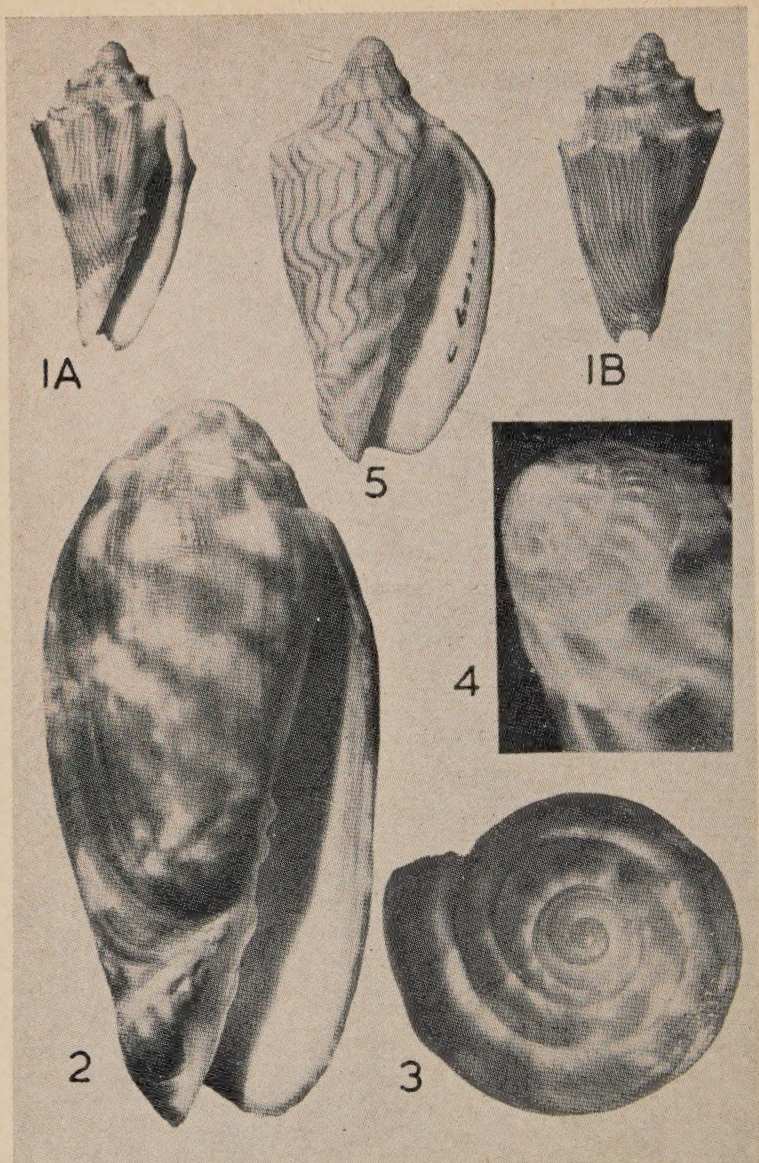


PLATE 1.

Figs. 1A, 1B. *Nannamoria parabola* Garrard. Holotype. Aust. Mus. C. 63141.  
Mag.  $1\frac{1}{3}$  X.

Fig. 2. *Volutoconus coniformis* (Cox). La Grange Bay, W.A. A. Whitworth Collection.  
Mag.  $1\frac{1}{3}$  X.

Continued at foot of page 3.

# A NEW SPECIES OF *NANNAMORIA* (MOLLUSCA: VOLUTIDAE) FROM SOUTHERN QUEENSLAND

By T. A. GARRARD.\*

The following new species of volute was collected during the fourth survey of the prawn fishery investigations made by M.V. "Challenge" along the eastern Australian coast, from November, 1959, to May, 1960.

Family Volutidae.

Genus *NANNAMORIA* Iredale.

*Nannamoria* Iredale, 1929, *Rec. Aust. Mus.* 17: 181. Types species by original designation, *Nannamoria amicula* Iredale, 1929, *Rec. Aust. Mus.* 17: 181, pl. 40, fig 4.

*Nannamoria parabola* sp. nov.

(Plate 1, figs. 1A-1B.)

**Remarks:** This new species is a beautiful addition to the genus, having much in common with the type species, but the shell is broader and heavier, with pronounced spines on the shoulders.

**Description:** Shell roughly conic in shape, spire acuminate, aperture four-fifths of the total length, recurved. Protoconch of three whorls, smooth and dome-shaped; adult shell with four additional whorls, the aperture produced at the posterior end over the spines of the preceding whorl; outer lip slightly thickened and roughly parallel with the recurved columella. Sculpture of faint growth striae, with short hollow spines on the shoulders, ten spines to each whorl, extending as pronounced axial ridges, fading towards the anterior end. Columellar plaits variable, being five and seven in two immature specimens, but no less than twelve in the adult holotype, varying considerably in size. Colour pale fawn, with fine longitudinal chestnut lines, some merging and some finishing abruptly. A band of small chestnut blotches encircles the shell in the middle of the body whorl, and another less definite below the spines, while a thickening of the chestnut lines at the anterior end suggests a third band of colour; outer lip and both ends of the inner lip white.

**Dimensions:** Holotype: length 35 mm., breadth 18 mm., length of aperture 29 mm.

**Type Locality:** All known specimens were trawled in 125 fathoms, off Moreton Island, Queensland.

**Types:** The holotype, a mature shell, has been presented to the Australian Museum, where it is registered as C.63141. A paratype is in the author's collection, while a second paratype is in the National Museum of Victoria, No. F.21107.

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\*3 The Circle, Dundas, New South Wales.

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Fig. 3. *Volutoconus coniformis* (Cox). Apical view to show sculpture. Mag 1 1/3 X.

Fig. 4. *Volutoconus grossi* (Iredale). Off Yeppoon, Queensland. Apex showing radial sculpture. Mag. approx. 4 X.

Fig. 5. *Paramoria guntheri* (Smith). Encounter Bay, S.A. Aust. Mus. C. 62111. Mag. 1 1/3 X.



# NOTES ON SOME AUSTRALIAN VOLUTIDAE

By DONALD F. McMICHAEL, Ph.D.\*

In the course of routine museum work, a number of interesting volutes have been submitted for identification or study during the past few years. In some cases, animals have been presented from which radula slides have been prepared, and these have yielded some interesting results. The following notes are intended to record some of the conclusions reached in preparation for a comprehensive study of the Volutidae.

For convenience, the various groups will be treated in the order suggested by Pilsbry and Olsson (1954), though this does not mean complete agreement with the scheme outlined by them. Study of the Australian representatives of this family has convinced me that the Volutidae can only be understood if they are conceived of as a series of relic genera, the end products of a major Tertiary evolution, now moving towards extinction. Only a few groups are really successful recent genera with more than a few species. These include the Australian genera *Amoria*, *Cymbiolacca*, *Aulica*, the Japanese *Fulgoraria*, the New Zealand *Alcithoe*, and the large-shelled genera *Melo* and *Cymbium*.

Subfamily ATHLETINAE Pilsbry and Olsson.

Genus *TERNIVOLUTA* Martens.

*Ternivoluta studeri* Martens.

Reference: McMichael, 1959, *Proc. Roy. zool. Soc. N.S.W.*, 1957-58, pp. 60-62, fig. 1.

*Remarks:* When I recorded the rediscovery of this species from Tin Can Bay, I noted that Schacko (1881) had previously figured the radula under the name *Voluta (Psephaea) concinna* (a Japanese species of *Fulgoraria*), but I did not consider the radula further. The genus *Ternivoluta* was placed next to *Volutocorbis* Dall by Thiele and by Pilsbry and Olsson, an arrangement which I followed on the shell characters, notably the columellar plaits. Study of the radula figured by Schacko shows that the species has a triserial radula very similar to that described for *Volutocorbis abyssicola* Adams & Reeve, thus confirming the generic relationship.

Since then, numerous specimens of *T. studeri* Martens were collected by the M.V. "Challenge" in December, 1959, from 68 fathoms, N.N.E. of Cape Byron, northern N.S.W. One of these contained an animal which was forwarded to me for study. This proved to be fairly typically volutid, but the siphon has no appendages (agreeing with *V. abyssicola* fide Pace (1902), p. 28). The eyes are carried at the end of short rounded eye-stalks, again agreeing with *V. abyssicola*. The colour pattern is of dark brown to black flecks and streaks over the dorsal surface of the foot, head and siphon. The radula agrees in detail with that described by Schacko, even to the exact number of rows of teeth, viz. 117; a typical row is illustrated in Text fig. 1, A.

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\*Curator of Molluscs, The Australian Museum, Sydney.

Subfamily FULGORARIINAE Pilsbry and Olsson.

Genus *MESERICUSA* Iredale.

*Mesericusa sowerbyi* (Kiener).

*Voluta sowerbyi* Kiener, 1839, Coquilles Vivantes, *Voluta*, pp. 47-48, pl. 50.

**Remarks:** This well-known eastern Australian shell has never been studied for animal and radula morphology, though it is one of the commonest of the deep-water volutes. Iredale (1929, p. 181) separated the species under the new generic name *Mesericusa*, naming the New South Wales form *M. sowerbyi perspecta* Iredale as type. Previously the species had been referred to *Ericusa* H. and A. Adams (type species by subsequent designation, Cotton and Godfrey, 1932, *S. Aust. Nat.*, 13, p. 49, *Voluta fulgetrum* Sowerby, 1825), but Iredale separated it on conchological grounds.

The animal of *E. fulgetrum* (Sowerby) has not, to my knowledge, been studied, but the radular tooth of its congener, *E. papillosa* (Swainson) was figured by Cooke (1922, fig. 8). This has a most unusual structure, being unicuspid, with a long, narrow central cusp set on a broad basal plate. This tooth structure seems to be unique among the Volutidae, though it recalls the *Scaphella-Amoria* type of radula, as Cooke suggested. If *E. fulgetrum* (Sowerby) proves to have a similar radula, then the genus *Ericusa* would seem to stand apart from the other Australian genera assigned by Pilsbry and Olsson to the Fulgorariinae.

*Mesericusa sowerbyi* (Kiener) exhibits considerable variation over its range from Tasmania to north New South Wales. The large, northern specimens which Iredale named *M. sowerbyi perspecta* may constitute a geographic race, but more specimens are required to answer this question. A single preserved animal, trawled by M.V. "Challenge" in 95 fathoms off Tuggerah Lakes, N.S.W., was available. The animal is a beautiful shade of reddish-purple, with numerous cream spots, circles and ovals covering the dorsal surface of the foot, head, siphon and penis. The siphon is long, firm, with fairly long, sub-equal appendages; the head is broad, with enlarged lateral lobes and slender tentacles, the eyes situated at their bases. The penis is a huge structure, some 2 in. or 3 in. in length in the preserved specimen, about  $\frac{1}{2}$  in. in thickness, with an approximately round cross-section but ridged along one side, and tapering to a blunt point. In preservation the penis is curled back behind the head, with its tip hidden under the edge of the mantle, and it probably lies in this position during life.

The radula is very large, with big, tricuspid teeth, their bases deeply and evenly arched, the number of rows 61. The teeth compare in general with those of *Livonia roadnightae* (McCoy) figured by Verco (1912, pl. 16, figs. 1-2), and the number of rows in the latter (70) agrees generally. A tooth from the radula of *M. sowerbyi* is figured in Text fig. 1, B.

Subfamily CYMBIINAE H. and A. Adams.

Genus *AULICA* Gray.

*Aulica* Gray, 1847, *Proc. zool. Soc. Lond.*, 1847, p. 141. Type species by monotypy, *Voluta aulica* Sowerby, 1825.

**Remarks:** I have previously discussed the use of this generic name for Australian volutes (McMichael, 1959, p. 375). Since then I have made some effort to find out which species should bear the name *Aulica*



*aulica* Sowerby, but this is still in doubt. However, the generic name is certainly applicable to the series of volutes found in Queensland and northern Australia, which have been variously known under the names *flavicans* Gmelin, *scafa* Solander, *signifer* Broderip, *mariaemma* Gray, *tissotiana* Crosse, *quaesita* Iredale, and *kellneri* Iredale.

There has been much discussion among collectors as to the validity of the last two names, and in an effort to determine the matter I have considered each of these names in detail, with results as follows.

*Voluta scafa* Solander, 1786. This name has recently been used by Maxwell Smith (1942, p. 41) and Cotton (1949, p. 188, 189) for the spinose form of the species usually referred to as *flavicans* Gmelin. Smith (1942) included *flavicans* Gmelin, *volvacea* Lamarck, and *signifer* Broderip in the synonymy of *scafa* Solander. How this conclusion was reached I cannot understand, for reference to the Portland Catalogue, where the name *scafa* Solander was introduced, shows that it is based on a figure in Adanson (1757, pl. 3, fig. 2), which is of a species of *Cymba* generally known as *porcina* Lamarck (based on the same figure). Therefore *Voluta scafa* Solander can be rejected for the present species.

*Voluta flavicans* Gmelin, 1790. This species was described from unknown locality, and only a few words of description are given. However two figures are cited, Seba, Plate 67, figs. a, b, and Martini, Conch. Cab., vol. 3, pl. 95, figs. 922 and 923. Only the latter work is available to me, and it shows a shell which is unquestionably the same as some of the northern Australian specimens, including paratypes of *Aulica quaesita* Iredale. This is a small, creamish-yellow shell, with obscure dark spots, without nodules or spines of any kind on the shoulder of the whorl, and with four strong columellar plaits. If the Seba plate shows a similar shell, then there can be no doubt that the name *Aulica flavicans* (Gmelin) should be applied to the "*quaesita*" type shell. The use of the name *flavicans* for the spinose shells probably is due to Sowerby (1844) and Reeve (1849), both of whom figured spinose shells as well as smooth ones. The presence or absence of spines however seems to have no taxonomic significance. *Voluta volvacea* Lamarck is an absolute synonym of *flavicans* Gmelin.

*Voluta signifer* Broderip, 1848. This was described briefly without figures or exact locality, though the specimen came from a Dutch collector, so that an Indonesian locality such as Amboina is not unlikely. The description indicates one of the *quaesita* series, but the exact identity will depend on an examination of the type. Reeve (1849) noted that the shell described by Broderip "is an elongated form of *V. flavicans* in which the lip is not quite mature". If a comparison is made with the specimens of *flavicans* figured by Reeve (both of which are stout shells) it follows that *signifer* must be very like the shell generally known as *tissotiana* or *kellneri*.

*Scapha maria-emma* Gray, 1859. This fine shell has been regarded as a northern Australian species, but the species was described as coming from Singapore (but with the reservation that it probably came from one of the Malayan Islands, Singapore being "merely the entrepot"). Examination of the figure given by Gray shows a most unusual shell, having the general shape and proportions of a northern Australian shell, but with the colour pattern and size of the common Indo-Malayan species generally known as *scapha* Gmelin, but which correctly should be called *Volutocorona nobilis* Solander. Until the type of *mariaemma* Gray can be



examined, it can be regarded as a form of *V. nobilis* Solander and not from Australian waters. Crosse provided the substitute name *grayae* for this species, on the grounds that *Scapha maria-emma* was not binomial; however this is not considered valid reasoning to-day, the name merely being written without the hyphen.

*Voluta tissotiana* Crosse, 1867. This shell was described from unknown locality, but it was compared with *flavicans* and *signifer*, and the figure shows a shell without doubt from northern Australian waters. Brazier identified shells collected at the Liverpool River, Arnhem Land, by the Cadell expedition in 1868 as *tissotiana*, and the name was generally used afterwards for the larger, less shouldered specimens from northern Australia. Iredale rejected it as an Australian shell, on the grounds that the specimen, which came from Robillard of Mauritius, was not Australian, but from Mauritius or a neighbouring island. However, our knowledge of volute distribution immediately rules out this suggestion, for the genus *Aulica* occupies a discrete range (like most volutid genera), and there are almost certainly no volutes of this group to be found outside the Australian-Indonesian-Coral Sea area. Iredale claimed that North Australia was still inaccessible at the time of naming, so a locality such as Timor, Amboina, or Ceram is probable, for shells of this type occur in southern New Guinea waters. This is the same form as was later named by Iredale *kellneri*, but whether it is the same as *signifer* Broderip remains to be seen.

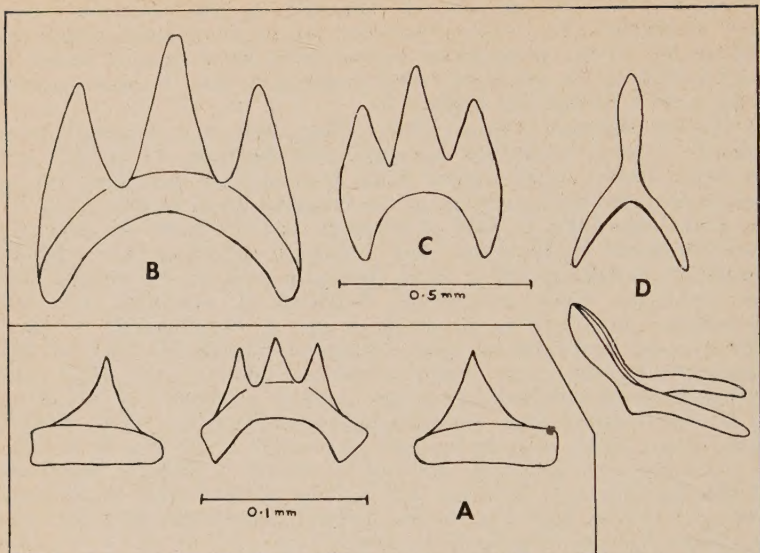
*Aulica quaesita* Iredale, 1956. The holotype and a series of paratypes of *Aulica quaesita* are in the Australian Museum. I am quite convinced that the series falls within the range of variation of the common northern Australian species, and this will bear the name *flavicans* Gmelin.

*Aulica kellneri* Iredale, 1957. This shell was separated from "*quaesita* Iredale" because of its more elongate form and spotted colour pattern. However, as indicated previously, I can see no grounds for the rejection of the earlier name *tissotiana* Crosse for this form. Whether there are two distinct species to be found in northern Australia, or only one, I am unable to decide. The series of specimens in the Australian Museum is not large enough to enable any valid conclusion to be reached. However, in view of the fact that volutes, because of their habit of laying attached eggs which hatch as crawling young, tend to develop colonies or populations of a fixed type with limited variability, but with each population differing from neighbouring ones, I think it likely that the northern Australian populations represent only a single, widespread species, which must bear the name *Aulica flavicans* Gmelin, with the names *signifer* Broderip, *tissotiana* Crosse, *quaesita* Iredale, and *kellneri* Iredale as synonyms.

#### *Aulica flavicans* (Gmelin).

*Voluta flavicans* Gmelin, 1790, *Systema Naturae*, Ed. 13, p. 3464.

*Remarks:* The radula and animal characters of the species *vespertilio* L. and *sophia* Gray and (in part) *rutila* Broderip are known, but as the first is the type of the subgenus *Aulicina*, while the second may also be referable to that group or to *Cymbiola*, only *rutila* Broderip refers to *Aulica* s.s.. The last named species was mentioned by Cooke (1922) as being included in the Gwatkin collection of radula slides, and Cooke noted that there were 71 rows, while the teeth had a Segmental Angle of 107°. However, the teeth were neither figured nor described. Consequently our knowledge of the typical *Aulica* radula has been strictly limited.



Text fig. 1.

Note: Figs. B, C, D are to the same scale.

A. A single row of radular teeth of *Ternivoluta studeri* Martens.

B. Radular tooth of *Mesericusa sowerbyi* (Kiener).

C. Radular tooth of *Aulica flavicans* (Gmelin).

D. Radular teeth of *Cymbiolista hunteri* Iredale, dorsal and lateral-oblique views.

A specimen of *A. flavicans* was collected alive by Mr. C. F. Kurtze, of Portland, Victoria, at Shoal Bay, near Darwin, N.T. Many specimens were seen on the mud-flats at low tide, and there were innumerable egg masses, attached to mangrove roots. Some additional information on the breeding habits of this species were given by Mr. Herbert T. Ward, of Guam, to Mrs. D. I. Hartley, of Melbourne, who kindly handed to me the specimen and Mr. Ward's notes for this paper. The specimen described is now in the Hartley collection.

The sides of the foot were a mottled purplish-brown colour, otherwise the animal is cream after some months preservation. The siphon is very prominent, stout and projecting, but not very long, with small subequal appendages. The head is small, without prominent tentacles, and with the eyes scarcely visible. The radula consists of a series of 46 tricuspid teeth, typically volutid, with arched base, long central cusp and shorter side cusps (Text fig. 1, C).

The egg masses collected by Mr. Kurtze were rather contracted in the alcohol preservative, but in life probably consisted of a number of spherical capsules, creamish-white in colour, and joined together in masses of 20 or more capsules. Each capsule of the egg masses collected contained a single, small shelled embryo, the shell consisting essentially of the protoconch of the adult, of  $3\frac{1}{2}$  whorls 11 mm. long by 7 mm. diameter, white with just one or two brownish markings towards the outer lip.



Mr. Ward noted that live specimens were taken on the surface of the mud in the act of laying eggs. The animal assumes a near perpendicular position with about two-thirds of the spire of the shell buried in the mud. The eggs are laid in clusters of transparent capsules attached to loose sticks or other mud-lodged debris which has been carried out by the tide. In one case two live shells were taken completely buried in the mud, with the egg mass above them, at a depth of approximately one foot. In another locality (Sampan Creek) numerous live specimens were found crawling on one small muddy area, and some specimens were again found buried under eight or ten inches of mud. However, this species must spend most of its time above the surface of the bottom mud, as the specimen dissected was carrying living barnacles of considerable size on the dorsal surface of the shell.

Genus *VOLUTOCONUS* Crosse.

*Voluta* (*Volutoconus*) Crosse, 1871, *J. Conchyliol.*, 19, p. 306. Type species by monotypy, *Voluta coniformis* Cox.

*Remarks:* Cox described *Voluta coniformis* in 1871, with an excellent figure and detailed description, from Nichol Bay, North-west Australia. The unique colour and form of the species caused Cox to write at the time "L'ensemble de ces caractères permettrait, peut-être, de créer, pour cette forme originale, une section particulière du genre *Voluta*".

This challenge was taken up by Crosse in the same year when he introduced *Volutoconus* for this species only, placing the section between "*Volutilithes* Swainson" (= *Volutocorbis* Dall) and *Callipara* Gray.

The genus received little attention subsequently, but some additional species were suggested as relatives of *V. coniformis*. First, Martens, when recording *Voluta bednalli* Brazier in the *Zoological Record* for 1879, commented "very near *coniformis* Cox"; a suggestion which was accepted by Hedley (1915), who used *Volutoconus* as a subgenus of *Cymbiola* for these two species; and recently Abbott (1958) suggested that *grossi* Iredale originally described as an *Amoria*, belonged with *bednalli* in *Volutoconus*, but expressed some doubt as the animal of *V. coniformis* Cox has not been examined. He also mentioned *Voluta hargreavesi* Angas as a possible relative, because of its resemblance to *V. grossi*. Allan (1956) had previously suggested that *hargreavesi* Angas and *grossi* Iredale were synonyms.

In all the years since 1871, to my knowledge, no specimen of *Volutoconus coniformis* has been noted in literature, nor has any figure or description been given, other than those copied from the original description. It is therefore pleasing to report the rediscovery of this species from two localities in Western Australia. A magnificent shell in the collection of Mr. A. Whitworth, of Carnarvon, was generously loaned for study. It was taken alive in about ten fathoms off La Grange Bay, Cape Bossut, about 250 miles north-west of the type locality. This specimen is illustrated on Plate I, fig. 2. A second specimen, considerably smaller and with an imperfect lip, is in the National Museum of Victoria, part of the Hartley Collection, registered as No. F.21090. This was taken by a skin-diver off Broome, W.A.

It is also of interest to record the rediscovery of *Voluta hargreavesi* Angas. This species was described without locality, but an excellent figure was given, showing a shell broader than *grossi*, with the apex flattened,

with the white triangle colour pattern on a reddish-orange ground. A specimen of this general description was reported to be in a Western Australian collection. Unfortunately, I was unable to borrow the specimen for study, but kodachromes kindly provided by Mr. Whitworth show that the shell is certainly the missing *hargreavesi*. The locality is uncertain, but probably the Abrolhos Islands, and certainly southern Western Australia.\*

Study of these shells has convinced me that all four species, *coniformis* Cox, *bednalli* Brazier, *hargreavesi* Angas, and *grossi*, are members of one genus. The apical sculpture of *coniformis* consists of numerous, fine radial ribs developing after the first two whorls, which are smooth (Plate 1, fig. 3). The slides of *hargreavesi* show a very similar sculpture, and radial ribbing is also seen in good specimens of *bednalli*. The original specimens of *grossi* found some years in Tin Can Bay, Queensland, and described by Abbott (1958) were absolutely without sign of radial sculpture on the apical whorls, which were glossy, with an exert terminal papilla. However, specimens collected recently in the general neighbourhood of Yeppoon and the Keppel Islands, do possess radially ribbed protoconchs. The ribs are more widely spaced than in the northern and western Australian species, and are covered with a glaze. A protoconch of this type is illustrated in Plate 1, figure 4.

There are some differences between the polished slender shells of *Volutoconus grossi* and those of the squat, reticulately sculptured *coniformis*, but these are linked by *hargreavesi*, which appears to have an unpolished, relatively stout, but unsculptured shell, and all share a similar colour pattern. *Voluta bednalli* Brazier differs in colour, but agrees well with one or other of the remaining species in shape, sculpture and radula tooth structure.

When Abbott (1958) described the radula of *grossi*, he was unable to give any morphological characters of the animal. A specimen of the animal, received from Mr. C. F. Knight, revealed the following features. The foot is banded with orange-red or pinkish bands on a cream background. The siphon is elongate, with long equal appendages. The head is compressed, with slender tentacles, the eyes prominent at their bases. The radula consists of 35 tricuspid teeth as noted by Abbott. It is noteworthy that the teeth are set at alternating angles on the basal membrane, so that the long central cusps are set in just the same manner as the teeth on a rip-saw.

The genus *Volutoconus* Crosse may be redefined as follows: Volutes of the subfamily Cymbiinae, with brightly coloured shells, either of blackish-brown, spiral and longitudinal bands on a cream shell, or of cream to white triangles on an orange-red to deep reddish-brown background. Spire elevated or quite depressed, apical whorls prominently radially sculptured with fine ribs, these sometimes obscured with an overlying glaze; with a central projecting papilla at the tip of the first whorl. Adult whorls in some species with fine, reticulate sculpture; in others smooth, with growth ridges only. Columellar plaits four or five, promi-

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\*A second specimen, agreeing in detail with the figure and description of *V. hargreavesi* Angas, was dredged alive off the central coast of Western Australia by the "Davina" during the Hawaiian-West Australian expedition of May/June, 1960. It will be reported upon at a later date.



nently developed, or smaller, widely spaced. Radula (where known) uniserial, with about 35-40 large, tricuspid teeth.

Subfamily SCAPHELLINAE H. and A. Adams.

Genus *CYMBIOLISTA* Iredale.

*Cymbiola* (*Cymbiolista*) Iredale, 1929, *Rec. Aust. Mus.* 17, p. 181. Type species by original designation, *Voluta marmorata* Swainson (= *Cymbiolista hunteri* Iredale).

*Remarks:* Hedley (1915) referred the species *marmorata* Swainson to *Aulica*, but later transferred it to *Cymbiola* (Hedley, 1918, p. M 73). Iredale separated it subgenerically from *Cymbiola*, later (1931, p. 223) raising it to full generic rank, at the same time renaming the species, *marmorata* being preoccupied. Smith (1942, p. 52) listed the species under *Amoria* without explanation, though the shell does not resemble an *Amoria* in any way. Pilsbry and Olsson (1954) overlooked the genus, unless they regarded it as included in *Cymbiola*.

A specimen of *C. hunteri* Iredale in the Australian Museum, No. C.16374, part of the "Thetis" collection from off Cape Three Points, N.S.W., in 41-50 fathoms, revealed a typically volutid animal, but the radula was of the *Amoria* type, very long, with approximately 267 teeth, Y shaped with a single, broad blade-like central cusp, and a deeply indented basal plate (Text fig. 1,D). Thus the reference of this species to the neighbourhood of *Amoria* is confirmed, and the genus *Cymbiolista* must be placed in the present subfamily.

Genus *NANNAMORIA* Iredale.

*Nannamoria* Iredale, 1929, *Rec. Aust. Mus.*, 17, p. 181. Type species by original designation, *Nannamoria amicula* Iredale.

*Remarks:* This genus was erected for a single species dredged off Montague Island, N.S.W. No generic characters were given, apart from the species description, and no comparative characters were indicated saving the statement, "a very curious little shell, suggesting *undulata* in miniature".

Subsequently Cotton (1949) included two South Australian recent species, *guntheri* Smith and *adcocki* Tate in the genus, as well as several Victorian and Tasmanian fossil species. The discovery of a second species of *Nannamoria* described earlier in this issue prompts reconsideration of the generic classification.

The two eastern species, *amicula* Iredale and *parabola* Garrard are obviously closely related, agreeing in the slit-like mouth, rising up over the penultimate whorl posteriorly, and in the series of fine columellar plaits, alternating with somewhat larger plaits. The protoconch is small, evenly rounded without notable sculpture; the colour pattern is of fine, reddish-brown lines, somewhat wrinkled, but not undulating.

On the other hand, the two South Australian forms, *adcocki* Tate and *guntheri* Smith (which are certainly races of a single species if not merely colour forms) are very different in appearance; they have widely expanded mouths, not produced posteriorly; the four columellar plaits are of normal size; the protoconch is smoothly rounded, white, hemispherical, without any sign of radial ribbing or spiral sculpture in available specimens; the colour pattern is of spaced undulating brown lines; and the shells are nearly twice the size of the eastern species.

In view of these differences, I consider the South Australian species to be generically separable from *Nannamoria*, though a study of the tertiary fossils from southern States suggests that there may be a distant common ancestry. I regard the southern species *adcocki* and *guntheri* as more closely related to the genus *Notovoluta* Cotton (type species *Voluta kreuslerae* Angas), which has a similar protoconch and columellar plaits. The relationship of the latter with the Queensland species *perplicata* Hedley and the new Caledonian *thatcheri* McCoy, remains to be proven.

#### PARAMORIA gen. nov.

Type Species: *Voluta guntheri* Smith, 1886 (Plate 1, fig. 5).

*Description:* A genus of volutes with shells of medium to small size, spire comparatively short, body whorl large, aperture three-fifths of total length, expanded, but not produced posteriorly; columellar plaits four, stout; whorls usually angled at the shoulder, bearing a series of blunt spines or knobs; protoconch smooth, hemispherical, of  $2\frac{1}{2}$  whorls, of normal size.

*Remarks:* The recent species range from South Australia to Western Australia, and are found living in from 15-55 fathoms. The fossil species attributed by Cotton to *Nannamoria* were *costellifera* Tate, *lirata* Johnston and *absidata* Cotton. All were found in Victorian and Tasmanian tertiary beds, and because of their comparatively large size, may be related to *Paramoria*, rather than to *Nannamoria*. The animal characters and radula of both *Paramoria* and *Nannamoria* remain unknown, but when found these should throw some light on the relationship between the two groups, as well as their subfamily classification.

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# CYPRAEA LEUCODON Broderip, 1828

By WILLIAM J. CLENCH, Ph.D.\*

This species has heretofore been known only from a single specimen in the British Museum. The Museum of Comparative Zoology at Harvard University possesses another specimen of this remarkable mollusc.

Our specimen has no locality data other than "Indian Ocean". It was originally in the collection of the Boston Society of Natural History. In 1918, all of that society's non-New England material was transferred to the Museum of Comparative Zoology. The original catalogue number (1206) was entered very early, probably around 1840, which would indicate that this specimen, as well as that of the British Museum, was collected well over a century ago. This fact in itself may possibly give us a lead as to a probable locality.

During the early days of the East India trade, sailing vessels made stops at many islands in the Indian Ocean. Contrary winds, storms or other delays made it imperative to replenish supplies of fruits and fresh meat, particularly the former, to combat the dreaded deficiency disease of scurvy. Thus, vessels well off-course would stop at any of these remote islands to take on provisions. May not one of these islands be the locality of *C. leucodon*?

Sailors engaged in the East India trade were aware of the value of shells, as the curio stores must have depended largely upon them for the specimens which frequently found their way into the cabinets of European collectors.

One such island group, the Chagos Archipelago, is known to have at least a few remarkable endemic marine species such as *Conus barthelemyi* Bernardi and *Cypraea barclayi* Reeve. It is possible that *leucodon* may be from this remote and very small archipelago.

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PLATE 2.

*Cypraea leucodon* Broderip, 1828.

Museum of Comparative Zoology, Harvard University. No. 38370. 1.24 X.

Length	Height	Width
77.5 mm.	43 mm.	54.5 mm.

The colouration of this specimen is very similar to that of the original figure of Broderip.

# THE LIFE HISTORIES OF MARINE PROSOBRANCH GASTROPODS

By D. T. ANDERSON, Ph.D.\*

## INTRODUCTION.

The Australian littoral, especially along its more northerly reaches, displays a diversity and richness of life equal to that of any part of the world. It is still true to say, however, that very little is known of the biology of Australian shore animals. Almost every common species presents problems of numbers, distribution, habits of life and ecological relationships, as well as of such less fashionable matters as comparative anatomy and physiology, each of which calls for intensive treatment if we are to have a full understanding of this conspicuous and colourful component of Australia's natural fauna. The present article calls attention to a small aspect of this vast and complex challenge to our curiosity, a field more neglected than most, and yet among the easiest to gain new information about, life history studies of the littoral representatives of the prosobranch gastropod molluscs.

A full understanding of the opportunities and the scope of the problems in this field demands that account be taken of the present state of our knowledge of prosobranch life histories. Numerous scientific papers have been contributed on the subject by many authors, dating back as far as the middle of the last century, but examination of them, while it yields much that increases our understanding, reveals two important facts. Firstly, it is clear that the numbers of prosobranch species whose life histories are known is greatly exceeded by the number unknown. Generalizations are thus accepted whose factual basis is knowledge of but a fraction of classified genera and species. Secondly, students of prosobranch life histories have made their observations almost exclusively on European and North American species. The species of the southern continents, including Australia, are for the most part different even within families represented in common in both hemispheres, while the southern shores offer further for study numerous tropical and sub-tropical species belonging to families whose life history patterns we know not at all. Since no true picture of any aspect of biology can be gained without encompassing reference to its entire range of manifestation, the significance of this gap in knowledge is plain.

The information that we require of these species can be simply outlined. Onset and duration of the breeding season, the number of fertilized eggs produced by each female, the manner in which the eggs are laid and the nature of the spawn in species where they are not shed freely into the water, details of egg size and yoliness, the duration of early development and the stage at which the embryo becomes a free-living feeding larva, the form of the larva and its detailed behaviour, the transformation of larva into adult at metamorphosis and the degree to which reorganization takes place, the mortality at each phase of development and the colonisation of the adult habitat by new individuals are all matters which have several kinds of significance. They are an essential part of the record of the natural history of one of Australia's most characteristic groups of animals: a prerequisite to understanding the

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evolution of the prosobranchs; and a basis for analysing ecological relationships among these animals, which cannot be done satisfactorily without knowledge of the mode of maintenance and increase of their populations and the factors which might bring about population movements and limit numbers and geographical range.

It is unfortunate for the intending worker in this field of study, open as much to the amateur as to the professional marine zoologist, that the numerous papers referred to above are scattered through a large number of scientific journals. Furthermore, although the more comprehensive of them review in some detail certain aspects of prosobranch life histories, there is no easily accessible source of reference to contemporary knowledge of the subject such as would quickly guide those wishing to further this knowledge through interest in their own local fauna. It is to fulfil such a need and to juxtapose the known and unknown in terms of specifically Australian opportunities that the present article has been prepared.

### A BRIEF SUMMARY OF PRESENT KNOWLEDGE.

The majority of littoral prosobranchs are, of course, dioecious, although hermaphroditism has been occasionally recorded, particularly in *Crepidula fornicata* (Calypttraeidae; Conklin 1897, Orton 1909, 1922, Ankel 1935, 1936, Lebour 1937, Werner 1955). The anatomical differences which allow the prosobranchs to be separated into three systematic orders, the Archaeogastropoda, Mesogastropoda and Neogastropoda\*, however, are accompanied by differences in their modes of breeding. Copulation is rare in archaeogastropods except in the Neritidae, the family most closely related to the mesogastropods. Eggs and sperm are either shed freely in large numbers into the water (Text fig. A; Fissurellidae, Haliotidae, Acmaeidae, Patellidae, some Trochidae) or deposited in groups embedded in a simple gelatinous matrix (Text fig. B; other Trochidae, Neritidae). Since in trochids which produce such jelly masses fertilization is external, a form of pseudocopulation involving association in pairs or groups, male and female together, must accompany spawning. Most archaeogastropods produce small microlecithal eggs, 60-100  $\mu$  in diameter, which develop rapidly into free-swimming trochophore larvae (Text fig. C) feeding on planktonic micro-organisms. Development of the free swimming larva quickly proceeds to shell formation, 180° torsion and the attainment of the basic prosobranch organization, with head, foot and visceral hump clearly outlined, the foot bearing a thin operculum, the visceral hump being covered by the already spirally coiled shell (Text fig. D). The prototroch of the trochophore becomes greatly enlarged to form the velum, the main propulsive organ of the now completed veliger larva. As planktotrophic life continues, the veliger enlarges and adds further to its shell. Within a short time metamorphosis ensues, the velum is either cast off or resorbed, and the veliger sinks to the bottom and assumes the crawling mode of life of the adult. Successful adoption of the latter depends on settlement on a suitable substratum, but little is yet known of the factors which influence or prevent settling in any species.

Some trochids, neritids and patellids produce larger eggs containing a greater volume of yolk. Here the trochophore organs are largely suppressed and the embryo either becomes free swimming as a lecithotrophic trochophore or remains within the jelly in which it is spawned. In the former case pelagic life is of very short duration, its significance being

\*Following the classification adopted by Morton (1959).



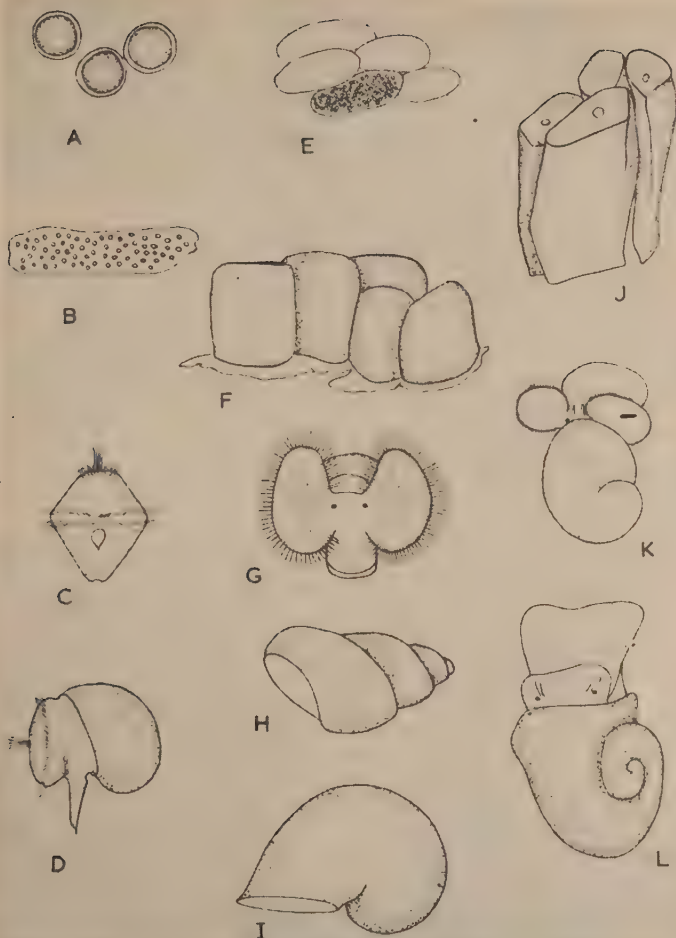
mainly distributive, and settling follows the initial transformation into a veliger with a simple velum, metamorphosis proceeding gradually once the adult habitat is attained. Where such large eggs are spawned in jelly, hatching from the jelly is generally delayed until the completion of metamorphosis, when the embryo emerges as a fully formed crawling miniature adult. One species of acmaeid, *Acmaea rubella*, becomes free at this stage after developing within the maternal oviduct. This is the only known case of viviparity among the archaeogastropods.

The course of development from the egg through to the smallest adult stage may vary between species of a single family, even between species of a single genus, a matter referred to by Coe (1949). The importance of such variations in assisting a taxonomic distinction between closely related species whose adults are almost indistinguishable is being increasingly recognized for marine invertebrates, but does not yet appear to have been exploited in prosobranch systematics save by Anderson (1958), who separates species of *Bembicium* on the basis of differences in their egg masses. Moreover, comparative studies of mode of deposition of the eggs (establishing the environment of early development), egg size and yoliness, the related degree of development of larval ciliation, speed of development and what might be called the retentiveness of the gelatinous spawn where present (some prosobranch egg masses offer more obstacles to escape of the embryos than others) have received little attention in prosobranchs, although it is obvious that they form an interrelated complex whose total effect broadly determines the life history patterns of species.

Among the mesogastropods, the much larger number of families is associated with a similarly greater diversity of life-history patterns. All of them, however, appear to be derived from the basic pattern of the primitive archaeogastropods.

All mesogastropods show copulation. Subsequently, the female produces eggs that are always yolky and deposited almost always in a cocoon. In the more primitive species this may be simply a gelatinous matrix, as in the archaeogastropods, or a group of such jelly masses together (Text fig. E). The trochophore stage is largely suppressed and passed within the jelly of the cocoon, so that hatching occurs at the earliest as a veliger (Text fig. G). This may be either active planktotrophic (Text fig. H), with a long planktonic life, or lecithotrophic, with a short planktonic life (Text fig. I). In the former a well-developed spiral shell of several whorls is formed during growth of the veliger in the plankton; in the latter, the shell is characteristically bulbous and shows little sign of spiral growth before metamorphosis. Metamorphosis is usually a rapid process in the planktotrophic veliger, settling as a miniature adult following it directly, but in the lecithotrophic veliger it proceeds gradually after settling has taken place. The same problems of larval settlement and the conditions which influence it exist in the mesogastropods as in the archaeogastropods, as do those of the relationship between mode of spawning, egg size, ciliation, etc. and pattern of the life history.

Great variation occurs in the egg cocoons. In a very few primitive species no cocoon of any kind is produced, the eggs being simply shed freely into the water. Most species produce jelly masses, but there are many which elaborate on this, laying a series of capsules each with a tough outer wall and internal jelly in which the eggs are embedded



Text figure. (Diagrammatic).

- A. Archaeogastropod eggs.
- B. Archaeogastropod jelly mass.
- C. Archaeogastropod trochophore.
- D. Archaeogastropod veliger.
- E. Primitive mesogastropod jelly mass (*Bembicium*).
- F. Advanced mesogastropod egg capsules (*Mayena*).
- G. Mesogastropod early veliger.
- H. Shell of planktotrophic late mesogastropod veliger.
- I. Shell of lecithotrophic late mesogastropod veliger.
- J. Neogastropod egg capsules (*Dicathais*).
- K. Encapsulated neogastropod veliger.
- L. Neogastropod crawling hatching stage.

(Text fig. F); while the capsules themselves may be deposited in a group of characteristic overall shape. Others lay a tough jelly string with a series of fluid-filled spaces inside, the eggs floating in the fluid, which appears to be a nutritive albuminous substance. In a few species, only one or two of the eggs in each space develop, the others forming nurse eggs which are utilized as food by the developing veligers. These more elaborate provisions for protection and ensured food supply are generally accompanied by suppression of the normal trochophore-veliger temporary organs, more direct development to hatching as a crawling miniature adult, and occasionally the precocious development of the adult feeding apparatus as a means to utilizing available food. Hatching from the spawn is greatly delayed in such species. There appears also to be a correlation between the length of planktonic veliger life and the number of eggs spawned by the female. Species with a long-lived planktotrophic veliger produce eggs in very large numbers: those whose development is direct generally produce many less eggs. A very few species of mesogastropod are ovoviviparous, retaining their eggs within a brood chamber, a specialized part of the oviduct, until their development is completed and they are born as young adults. The European *Littorina saxatilis* is one such species. In fact a clear adaptive relationship between life history pattern and distribution on the shore is seen for the European littorinids, which exhibit a zonation as marked as that of the *Bembicium*—*Melaraphe*—*Nodilittorina* zonation of the Australian coast.

*L. littorea*: lower littoral—eggs laid in floating jelly masses, long planktonic life.

*L. obtusata*: mid-littoral—eggs laid in jelly masses, hatch crawling.

*L. saxatilis*: upper littoral—ovoviviparous, born crawling.

*L. neritoides*: upper littoral—eggs released freely into sea, long planktonic life.

The exceptional life history of *L. neritoides*, which although it is highest on the shore of all these species, shows no obvious adaptation to breeding in such a situation, only emphasises how difficult it is to make generalizations about prosobranch life histories and how great is the need for further information. We do not yet know if comparable adaptations are to be found among the Australian species.

As with the archaeogastropods, the pattern of the life history in mesogastropods may vary within families, even within genera, from the extremes of long pelagic planktotrophic life to direct adoption of the benthic crawling habit. The wide variation that is possible within a single genus is clearly displayed by the example of the littorinids mentioned above. No mesogastropod, however, hatches before the veliger stage.

The neogastropods in general resemble the most specialized of the mesogastropods in their life histories. All of them lay eggs in tough capsules filled with gelatinous fluid (Text fig. J). The eggs may be relatively small, with escape taking place at the veliger stage to a long pelagic planktotrophic life, but usually the eggs are large and yolky, hatching is delayed and pelagic life is either very short or omitted (Text figs. K, L). In some species development within the capsules may take several weeks, hatching occurring as a relatively large juvenile. Nurse eggs are characteristic of certain families of neogastropods, and almost all species provide an albuminous nutriment for the encapsulated



embryos. The problems of relation between mode of oviposition and mode of development, of larval settlement and distribution, etc., are as obvious for the neogastropods as for other prosobranchs, while generic and familial variation again need further detailed study.

In general it can be said that the archaeogastropods tend towards a short pelagic life, the mesogastropods towards a long pelagic life, while in most neogastropods the pelagic phase is omitted. The mesogastropods are thus perhaps the most difficult subjects for life history studies, since even if their egg masses can be found and identified, their planktotrophic veligers are very sensitive to culture conditions, and usually die after a few days. However, in such circumstances a fairly accurate estimate can be made of whether or not the type of veliger under consideration is an important constituent of the plankton by examining:

- (a) The numbers of eggs hatching as veligers, which should be high.
- (b) The ciliary feeding mechanism of the veliger, which should be conspicuous and elaborate.
- (c) The veliger shell, which should be well developed and spirally coiled.
- (d) The absence of yolk from the visceral hump and advanced differentiation of the internal organs.

It has been demonstrated from a number of studies of prosobranch life histories that in the colder regions of the northern hemisphere planktonic larvae are either absent or exceptional, but that they become more common among species of the temperate zone, and are almost exclusive among tropical species. Such studies, however, may not reflect the position of the Australian fauna, since they have not included numerous species of neogastropod such as are characteristic in this country. Only detailed investigation of our many unique species can determine whether or not the tentative conclusions that have emerged from studies in the northern hemisphere can be applied without qualification to the Australian littoral prosobranchs.

## AN APPROACH TO THE PROBLEM.

Familiarity with the general pattern of life histories to be expected among our littoral prosobranchs, together with a synoptic view of the many aspects of a life history relevant to a complete picture, provide a starting point for the investigation of individual local species. In order to indicate those which would repay study, a summary is given below of the littoral genera which have species commonly represented along various parts of the Australian coast, together with such information as we have about their life histories; and for comparison, species of the same families whose life histories are known, with references to their description, are listed. Of the latter, only species for which a reasonably full account is available are mentioned, and only the important references given for each. These will lead the interested reader to other references and to the few other species of which we have fragmentary knowledge. It is also essential to take account in studies of this kind of the work of Lebour (1937) and Thorson (1946, 1950), whose summaries of the life histories of the prosobranchs of distinct faunal areas, namely, the British prosobranchs and the Danish Baltic prosobranchs, are the only comprehensive accounts of their kind available.

## (1) Order ARCHAEOGASTROPODA.

Fissurellidae. — Only for one species of this interesting primitive family, *Diodora apertura*, is the life history known (Boutan, 1885), and this species is unusual among primitive archaeogastropods in spawning its eggs in a jelly mass from which the young hatch crawling. Species of *Tugali*, *Emarginula*, *Montfortula*, *Scutus*, *Elegidion*, etc., would no doubt provide a much broader picture of the life histories of the family.

Haliotidae. — One European species of haliotid, *Haliotis tuberculata*, has been intensively studied (Crofts, 1937, 1955), and one Japanese species, *Haliotis gigantea*, in less detail (Murayama, 1935). Both shed their eggs freely into the water and have a planktotrophic trochophore and veliger. We do not yet know whether this is also true of the Australian species of *Haliotis*, *Notohaliotis* and *Gena*.

Trochidae. — While three northern hemisphere species of trochid, *Gibbula magnus*, *G. cineraria* and *G. umbilicalis*, shed their eggs freely and have planktotrophic trochophores and veligers (Robert 1902), all other described species deposit their eggs in jelly and hatch at the crawling stage (*Gibbula tumida* (Gersch 1936), *Calliostoma ziziphynum* and *C. papillosum* (Lebour 1936, Crofts 1955), *Margarites helcinus* (Thorson 1935), *Cantharidus* (= *Trochus*) *exasperatus* and *C.* (= *Trochus*) *striata* (Robert 1902)). Study of the many Australian species included in the genera *Austrocochlea*, *Trochus*, *Clanculus*, *Thaliota*, etc. would greatly extend our knowledge of trochid life histories. *Trochus niloticus* is reported by Moorhouse (1932) to shed its eggs freely in the primitive manner.

Turbinidae. — Nothing appears to be known of turbinid life histories save that the British species *Tricolia pullus* sheds its eggs freely into the water (Lebour 1937). The many common species of Australian genera such as *Turbo*, *Ninella*, *Subninella* and *Bellastrea* could serve to establish the typical life history patterns of the family.

Acmaeidae. — The few known species of acmaeid show a wide range of life history patterns. *Patelloida virginea* sheds its eggs freely and has planktotrophic trochophores and veligers (Boutan 1898, 1899). *Patelloida tessulata* (= *Acmaea testudinalis*) lays its eggs in jelly, from which the embryos hatch as pelagic veligers (Wilcox 1905). *Acmaea rubella*, an arctic species, is viviparous (Thorson 1935; see p. 18). Presumably the Australian species of *Notoacmaea*, *Patelloida*, etc., fit within this pattern, but we do not yet know where.

Patellidae. — All patellids so far studied shed their eggs freely and have planktotrophic trochophores and veliger larvae (*Patella vulgata* (Dodd 1957, Crofts 1955, Smith 1935), *Patella cerulea* (Patton 1886, Lo Bianco 1899), *Patina pellucida* (Crofts 1955, Lebour 1937, Smith 1935)). Artificial fertilization appears to lead to successful culture in this family and could be employed for local species of *Cellana*, *Patellanax*, etc.

Neritidae. — All neritids so far studied, unlike other archaeogastropods, deposit their eggs in dome-shaped hard capsules. Hatching generally takes place at the crawling stage (*Nerita albicella*, *N. reticulata*, Risbec 1932) after a long period of development, though in three species of *Nerita* from Bermuda Lebour (1945) suggests that there may be a pelagic phase in the life history. A brackish water species, *Neritina*

*fluvialis*, is unusual in having nurse eggs within the capsule, with only a single embryo hatching (Bondensen 1940). Nothing is known of Australian neritid life histories save that the very common *Melanerita melanotragus* produces typical neritid egg capsules (Hedley 1916, 1923).

## (2) Order MESOGASTROPODA.

Littorinidae. — Reference has already been made (p. 20) to the wide variety of life history patterns shown by the littorinids and to their partial adaptation to environment. The details that have been obtained for northern hemisphere species are summarised below:

- (a) Eggs laid singly in floating capsules, hatching as planktotrophic veligers:

*Littorina littorea*—lower littoral: Hayes (1929), Linke (1934), Lebour (1937), Moore (1937).

*L. neritoides*—supra-littoral fringe: Lebour (1935b).

<i>L. zigzag</i>	}	Lebour (1945).
<i>Tectarius muricatus</i>		
<i>Echinella trochiformis</i>		

- (b) Eggs laid in jelly, hatching as planktotrophic veligers.

*Lacuna divaricata*: Hertling and Ankel (1927).

Hertling (1928, 1931), Lebour (1937).

- (c) Eggs laid in jelly, hatching at crawling stage.

*Littorina obtusata*—mid-littoral: Pelseneer (1911), Delsman (1914), Linke (1934).

*Lacuna pallidula*: Hertling and Ankel (1927), Lebour (1937), Gallien and Larambergue (1938).

- (d) Ovoviviparous, young born as planktotrophic veligers.

*Littorina angulifera*—supra-littoral, mangrove swamps: Lebour (1945).

- (e) Ovoviviparous, young born at crawling stage.

*L. saxatilis*—upper littoral: Pelseneer (1911), Delsman (1914), Linke (1934).

As already pointed out (p. 20), we do not yet know whether the Australian littorinids show corresponding adaptations of the life history to environment, an especially interesting case being the *Bembicium*, *Melaraphe*, *Nodilittorina* zonation familiar to all students of rock platform prosobranchs. This group of animals calls for close attention.

Planaxidae. — Nothing is known of planaxid life histories. Species of several local genera, notably *Hinea* and *Planaxis*, could easily be studied.

Rissoidae. — Lebour (1937) points out that the numerous species of small snails included in the Rissoidae probably make an important contribution to the plankton of British waters, and the same may be true of Australian waters, since many rissoid species abound along our coasts. Again, however, we know nothing of their life histories, and indeed only a few are known within the entire family. They characteristically produce oval, tough, thick-walled egg capsules, each containing a small number of eggs (*Onoba semicostata*, *Alvania punctura*, *Rissoa sarsi*, *R. inconspicua*, Lebour (1934a, 1935, 1937)). The three last named species hatch as planktotrophic veligers: the first hatches at the crawling stage.



Cerithiidae. — The opportunity to extend our knowledge of the life histories of cerithiid prosobranchs lies with the coral reef genera of the north, notably *Cerithium*. The need for such study is shown by the fact that only two cerithiids have been briefly examined so far, the Hawaiian *Clava obeliscus* (Ostergaard 1950) and the Bermudan *Cerithium ferruginum* (Lebour 1945), both of which lay long coiled gelatinous egg strings from which hatch planktotrophic veligers.

Potamididae. — Of this family, closely related to the cerithiids, we have even less knowledge. Only one species, *Bittium reticulatum*, has been adequately studied (Lebour 1936) and found to lay its eggs in a jelly mass from which again hatch planktotrophic veligers. The very common *Pyrasus* and *Bittium* species of Australia could thus be studied to advantage.

Turritellidae. — The turritellids again are almost unknown. Only the life history of *Turitella communis* has been recorded (Lebour 1933a), its eggs being laid in a jelly mass from which lecithotrophic veligers with a short pelagic life emerge. The common turritellids of Australia, e.g., *Turritella* and *Gazameda* species, have not been examined.

Scalidae. — The life histories of two species of *Scala* are known (Vestergaard 1935, Lebour 1937), their eggs being laid in small capsules and probably hatching as planktotrophic veligers. Further, one of these species, *S. clathrus*, is reported to be a protandrous hermaphrodite (Ankel 1936, 1938). Although they are not especially common as Australian littoral forms, scalid species do occur, and may well provide interesting additions to this fragmentary story.

Strombidae. — Like the cerithiids, strombs are characteristic reef animals, yet we know little of their life histories. Ostergaard (1950) and Risbec (1932) report that *Strombus maculatus*, *S. rugosus* and *Lambis* (= *Pterocera*) *lambis* all lay long, fine, coiled gelatinous egg strings, somewhat like those of opisthobranchs, and that the eggs of *S. rugosus* hatch as pelagic veligers. The Australian reef species have not been studied.

Naticidae. — All naticids appear to produce a characteristic spawn, a cylindrical ribbon of jelly covered externally by sand grains and having inside large individual egg spaces filled with nutritive albumen. The life histories of three northern hemisphere species have been studied, and show a wide range of variation. *Natica nitida* (Hertling 1932, Lebour 1937) hatches as a planktotrophic veliger, *N. pallida* (Thorson 1935) hatches at the crawling stage and *N. catena* (Ankel 1930), (Hertling 1932) hatches again at the crawling stage after a long period during which it feeds on nurse eggs. How far the life histories of Australian species of *Conuber* (= *Uber*), *Natica* and *Mamilla* correspond to any of these types is unknown.

Cypraeidae. — Although the cypraeids are among the best known of Pacific prosobranchs, astonishingly little is known of their life histories and nothing at all for Australian species. Ostergaard (1950) describes the early stages of five Hawaiian species of *Cypraea*, all of which lay numerous small horny capsules from which hatch planktotrophic veligers, and records instances of brood protection on the part of the females. Lebour (1932) describes similar capsules and veligers for *Simnia patula* and (1937) mentions that brood protection and small horny capsules are typical of the family.

Lamellariidae. — Only a few lamellariid species are recorded for Australia, and little is known of them, but any of them would repay further examination as to their life histories, for such information as we have on this family shows it to have a unique pattern of development involving planktotrophic veligers characterised by an additional larval shell, presumably flotatory in function, known as echinospiras. Furthermore, the eggs are laid in capsules within holes bored in the tests of compound ascidians by the spawning female. Such a life history pattern has been recorded for *Lamellaria conspicua* (Ankel 1935, Lebour 1935a) and *Trivia europea* (Pelseneer 1926, Lebour 1931b), and is probably followed by *Velutina velutina* (Lebour 1935, 1937).

Cassidae. — Nothing is known of cassid life histories. As with cerithiids, the common Australian species of *Cassia*, *Xenogalea* and *Phallium*, etc., provide a unique opportunity to fill this gap.

Cymatiidae. — Many well-known species of cymatid occur on the Australian coast, belonging to such genera as *Charonia*, *Monoplex*, *Cymatilesta* and *Mayena*. The life history of *Cymatilesta spengleri* has been described (Anderson 1959), the eggs being laid in an elaborate group of capsules from which hatching occurs at the crawling stage; but no other life history within the family is known. Variations in the life history patterns of different species must be considerable, however, and deserve further study, since Lebour (1945) records planktotrophic veligers for two species of *Cymatium* from Bermuda.

### (3) Order NEOGASTROPODA.

Buccinidae. — Life histories are recorded for three species of buccinid, *Pallia tinctoria* (Lebour 1945), *Sipho* sp. (Thorson 1935) and *Buccinum undatum* (Portmann 1925, 1926, 1927, 1930, Lebour 1937). All lay their eggs in tough capsules and are typified by many nurse eggs and the hatching of a few young at the crawling stage. It would be interesting to know whether the Australian species of *Cantharus*, *Cominella*, etc., confirm this as the typical pattern.

Nassariidae. — Like the buccinids, the nassariids appear to show a single life history pattern characteristic of the family, producing horny, tough, bottle shaped capsules from which the young hatch as planktotrophic veligers. This has been found for *Nassarius reticulatus* (Pelseneer 1911, Ankel 1929, Lebour 1931a, 1937), *N. pygmaeus* (Vestergaard 1935) and *N. incrassatus* (Lebour 1931a). We do not yet know if it is true for Australian species of *Nassarius*, *Parcanassa*, etc.

Fascioliidae. — Very little is known of fascioliid life histories. Portmann (1955) provides a little on *Fusus*, while Allen (1950) briefly refers to the Australian species *Pleuropoca australasia*, which lays its eggs in bell-shaped capsules from which the young, after a cannibalistic existence, hatch at the crawling stage. We need to know much more of species of such genera as *Colus* and *Peristemia*.

Galeolidae. — One of the largest of all prosobranchs, *Megalotactus aruanus*, graces the Australian shore as a member of this family. Allen (1950) describes the complex egg capsules of this species, from which the young hatch at the crawling stage, but we do not yet know the details of its development or of that of any other galeolid save *Fulgur*, described by Conklin (1907), with a life history pattern similar to that of *Megalotactus*.

Muricidae. — The life histories of several species of muricid have been described. All lay their eggs in vase-shaped capsules, from which the young hatch at the crawling stage (*Trophon muricatus* (Lebour 1936), *T. clathratus* (Thorson 1940), *Murex blainvillei* (Franc 1948), *Urosalpinx cinerea* (Lebour 1937), *Nucella lapillus* (Pelseneer 1911, Portmann 1925, 1926, 1930, Lebour 1937), *Neptunea antiqua* (Thorson 1935, 1941)), while in the two last-named species the young consume numerous nurse eggs before hatching. *Bedeva* (= *Trophon*) *hanleyi* is the only Australian species whose life history is known (Hedley 1916), and it resembles those species above which lack nurse eggs. Much remains to be learnt of species of *Chicoreus*, *Acupurpura*, *Murex*, *Agnewia*, etc., on Australian shores.

Mitridae. — Species of mitre shell remain common yet unstudied, in such genera as *Vexillum*, *Strigatella* and *Vicimitra*. The only information on life histories in this family is provided by Ostergaard (1950), who states for *Mitra astricta* and *M. auriculoides* that the eggs are laid in vase-shaped capsules and the young hatch as late veligers, probably briefly pelagic.

Conidae. — The many species of cone common on Australian shores again have unknown life histories. A few species have been briefly studied in other countries by Ostergaard (1950), Lebour (1945), Thorson (1940) and Risbec (1932). All lay their eggs in flattened egg pouches, but while the majority hatch as planktotrophic veligers, at least one species, *Conus omaria*, hatches at the crawling stage.

Turridae. — In this family, as in the cones and mitres, many species occur and none have been studied. We have some information from the work of Vestergaard (1935) and Thorson (1935) to show that some species of *Bela* hatch crawling, while Lebour (1933b, 1934b, 1937) has shown that species of *Philbertea* and *Mangelia* have planktotrophic veligers. Eggs always appear to be laid in lens-shaped capsules.

Volutidae. — Volutes are numerous on Australian shores, and in other parts of the world, yet only one species has been investigated as to its life history. This is the well-known Australian Baler shell, *Melo umbilicata*, which is described by Allen and Middleton (1946) as producing a complex mass of egg capsules from which the young hatch crawling at a late stage of development. As with the cones and so many other families, there are numerous problems of distribution and systematics in the volutes which require as an aid to their solution a detailed knowledge of life histories.

For the rest, the Thaididae (*Mancinella*, *Dicathais*, *Morula*, etc.), Magilidae (*Rapa*, *Magilus*, etc.), Harpidae (*Harpa*, etc.), Olividae (*Oliwa* spp.), Marginellidae (*Marginella* spp.) and Terebridae (*Terebra*, etc.), not only is there no recorded knowledge of the life histories of Australian species, but there is no information as to the life history patterns of any species. Among these completely unknown families and among those for which we have an amount of information that, as shown above, is small at best, the problems outlined in the introduction stand out strikingly. No one worker can possibly solve them all. It can only be hoped that all those whose interests lie among molluscs will see fit to add where they can to this fascinating and biologically important story.

I would like to thank Miss I. Bennett and Dr. D. F. McMichael for their advice on a number of matters connected with this paper.



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# A NEW *MELIOBBA* FROM THE SCHRADER RANGE, NEW GUINEA

By W. J. CLENCH, Ph.D.\* and R. D. TURNER, Ph.D.†

Through the kindness of Dr. D. F. McMichael, of the Australian Museum, Sydney, we received a new and unique specimen of *Meliobba*, a genus in the sub-family Papuinae.

*Meliobba* is a genus of wide distribution in New Guinea and in northern Queensland, Australia. Individual specimens of all species appear to be quite rare, judging by the very few specimens we have seen.

## Genus *MELIOBBA* Iredale.

*Meliobba* Iredale, 1940, *Aust. Nat.*, 10: 240. Type species by monotypy, *Meliobba shafferyi* Iredale.

### *Meliobba helenae* sp. nov.

*Description:* Shell reaching 40 mm. in greatest diameter, rather solid in structure, but thin, rimately perforate and finely sculptured. Whorls  $4\frac{1}{2}$ , depressed, and having an exceedingly sharp peripheral keel. Colour a mottled gray and brown on the early whorls, changing to greenish gray on the body whorl; interior of shell a dark mahogany-brown. Spire depressed, obtuse and cast at an angle of  $120^\circ$ . Aperture ovate and produced at an angle of about  $30^\circ$  from the base of the shell. Parietal area glazed with dark mahogany-brown. Palatal lip white, thin and reflected. Columella short and somewhat broadened. Suture indistinct. Umbilicus nearly covered by the columella reflection. Sculpture both above and below the periphery consisting of numerous fine, axial ridges and growth lines which parallel the margin of the lip. The surface above the periphery near the aperture is slightly malleated. Nuclear whorls 2, the apex brownish and with fine recurved thread-like ridges emanating from the suture.

The upper surface of the foot is brownish-yellowish in colour; the sole is deep ivory, becoming yellow near the margin. The remainder of the body is dark brown. The tentacles, when fully extended, are very long, nearly black, with swollen yellow-brown tips and minute black eyes. The genital pore is at the base of the right tentacle, and is margined with yellow-brown.

<i>Dimensions:</i>	Height	Greater diameter	
	22.5 mm.	40 mm.	Holotype.

*Types:* The holotype is in the Australian Museum, No. C.62378, and is from Asai-Simbai Divide, Schrader Range, a few miles due west of Aiome, Territory of New Guinea (Aiome is at  $05^\circ 05' S$ ;  $144^\circ 50' E$ ) at 5000 feet, collected by R. Bulmer, February 24, 1960.

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*Remarks:* *Meliobba helenae* differs from all other species in this genus by having the sculpture composed of very fine axial threads and not the more or less spirally arranged, interlacing ridges that are characteristic of all other species. It also differs from all others by its exceedingly acute keel. Named for Mrs. Donald (Helen) McMichael.



PLATE 3.

*Meliobba helenae* Clench and Turner. Holotype. Australian Museum,  
No. C.62378 (x 2).

# A NOTE ON "*PETTANCYLUS*" *AUSTRALICUS* (Tate).

By BENGT HUBENDICK, D.Sc.\*

Some years ago, Miss L. M. Angel, of the Department of Zoology, University of Adelaide, kindly sent me a sample of "*Pettancylus*" *australicus* (Tate, 1880, p. 102, pl. 4, fig. 4a-b) from the Torrens River, South Australia. The sample contained 168 specimens. One sectioned specimen appeared to be aphyallic. Subsequent examination by transparent light revealed that aphyaly is the normal state in this species or at least in the population examined. Only ten of the 168 species appeared probably to be phallic by this preliminary examination. Checking by serial sectioning showed that only seven specimens in the total sample had a complete reproductive system. These conditions add to the interest of the species, and a general morphological account of it may be of some value. This account is based on the intact specimens of the sample, nine serially sectioned specimens, and radula mounts.

The shell (Text figs. 1-3) reaches a maximum length of 3.8 mm. in the material examined. The corresponding maximum breadth is 2.2 mm., and height 1.0 mm. The size proportions vary slightly. The apex is smooth, but at a magnification of 50x a faint radial sculpture is sometimes visible on the apical region. The apex is located near the right side of the shell and about  $\frac{1}{4}$ - $\frac{1}{6}$  of the shell length from its rear end. The location of the apex and the morphology of the body indicates a vestigial pseudo-dextral shell. The anterior end of the shell is bluntly rounded, the posterior end somewhat more pointed, and located to the left of the median line. An extremely faint concentric sculpture is present. The transparent periostracum reaches well beyond the calcareous shell border. The colour of the shell is pale yellowish-brown.

One of the 168 specimens is septate (Text figs. 2-3), having the posterior part of the aperture closed by a septum of complete shell material. Some authors have regarded this feature as being of taxonomic importance, whereas others have regarded it as a kind of ecophenotypic adaptation (cf. Basch's review of the problem, 1959). The present case of septation does not support any of these views.

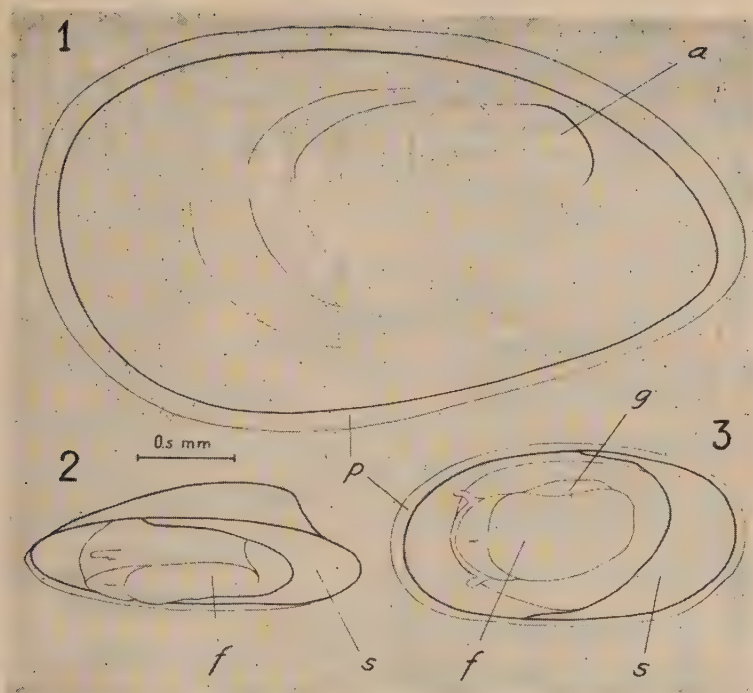
As in ancyliids in general, the eaves-like mantle border runs all around the animal. The foot has a somewhat rectangular sole. The tentacles are slender but not sharply pointed. A rather thin, unbranched but slightly folded pseudobranch is present. The anterior end of this gill is thicker and the anal pore is located on its dorsal surface. The mantle opening, the excretory pore and the genital pores are also on the left side of the animal.

There are three strong so called shell adductors (text fig. 5), one on either side anteriorly and one posteriorly to the left. Between the two left adductors is the shallow, widely open mantle cavity. Above the anteriorly located main portion of this is part of the pericardium, which reaches further to the right. A narrow reno-pericardial duct connects the lumen of the pericardium with that of the kidney. This has a

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Text figs. 1-3.

*"Pettancyclus" australicus* (Tate).

1. Dorsal view of shell.

2. Oblique left side view of septate shell with animal.

3. Ventral view of same specimen as in fig. 2.

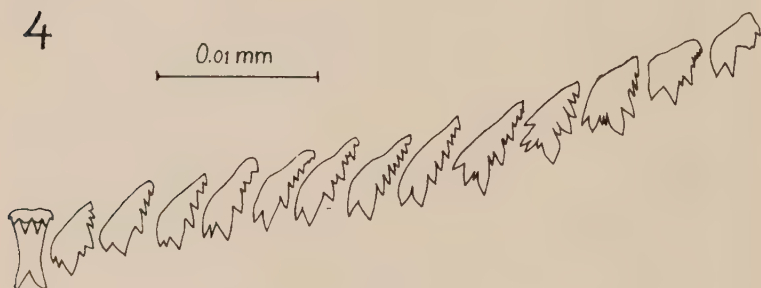
*a*, apex. *f*, foot. *g*, pseudobranch. *p*, periostracal shell edge. *s*, septum.

sac-like proximal portion and a sausage-shaped distal portion, which continues directly in the almost equally long urethra. The renal pore near the posterior end of the urethra is extremely narrow, and opens out under the mantle border. The kidney and the urethra form together a serpentine duct. The junction between its two elements is at the bend near the left posterior corner of the pericardium.

An osphradium is located in the mantle furrow near the left anterior shell adductor.

The jaw consists of a single row of separate chitinous condensations along the anterior and lateral sides of the mouth. The number of such chitin bars is about 75.

The buccal bulb occupies the major part of the head. The salivary glands (text fig. 6) are comparatively short and joined behind above the oesophagus. Their ducts are slender. The radula sac is short. The radula (text fig. 4) has about 27 teeth per cross row. The central tooth is symmetrical and has six cusps; of these the two central ones predominate, the more peripheral cusps are small and the most peripheral ones are visible only when the tooth is dislocated. The lateral teeth have up to eleven cusps. The four most peripheral teeth may be regarded as marginals, although a real distinction between laterals and marginals does not exist.



Text fig. 4.  
*"Pettancyclus" australicus* (Tate).  
 Half a cross row of the radula.

The oesophagus increases slowly in width behind the buccal bulb. There is no crop, but the oesophagus joins directly the well-developed gizzard. The pylorus region of the stomach adheres to the dorso-posterior side of the gizzard. The two independent, richly branched complexes of the digestive gland are connected with the pylorus. From this, near the pore of the anterior gland complex, a well-developed coecum branches off from the pylorus. The intestine leaves the pylorus parallel with the coecum and makes two loops before merging into the rectum. This runs towards the middle portion of the left side of the body. The anal pore is situated in the pseudobranchial fold.

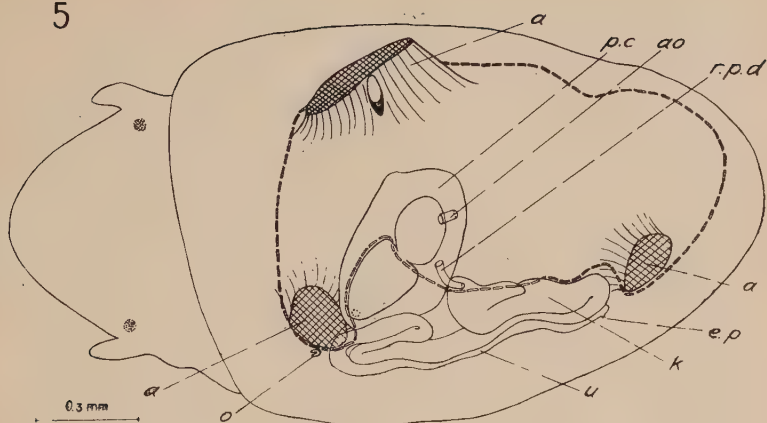
#### Text figs. 5-7.

*"Pettancyclus" australicus* (Tate).

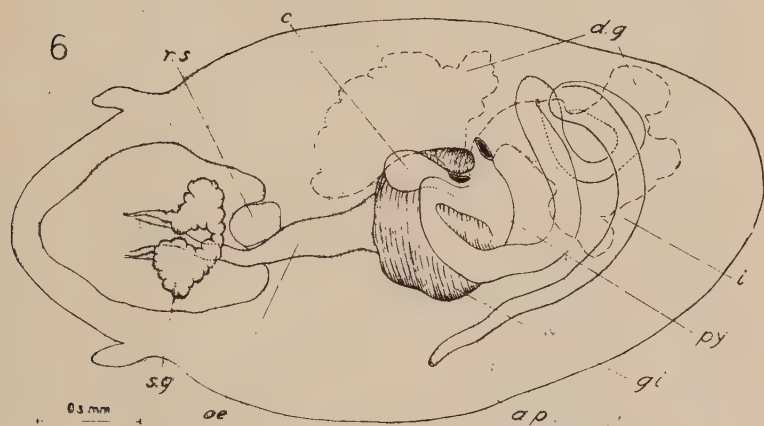
5. Diagram of adductor muscles and pallial organs. Dorsal view. The line of small rectangles represents the mantle cavity and the junction between the mantle border and the main body.
6. Diagram of the alimentary tract. Dorsal view. The fine broken lines indicate the outline of the digestive glands.
7. Diagram of the reproductive system, viewed from the left.

*a.*, adductor muscles. *a.g.*, albumen gland. *ao.*, aorta. *a.p.*, anal pore. *c.*, caecum. *ca.*, carrefour. *d.g.*, digestive glands. *e.p.*, excretory pore. *fl.*, flagellum. *fp.*, female genital pore. *gi.*, gizzard. *go.*, gonad. *i.*, intestine. *k.*, kidney. *m.o.*, male copulatory organ. *m.p.*, male genital pore. *o.*, osphradium. *o.e.*, oesophagus. *p.c.*, pericardium. *pr.*, prostate. *py.*, pylorus. *r.p.d.*, reno-pericardial duct. *r.s.*, radula sac. *s.g.*, salivary gland. *sp.*, spermatheca. *u.*, urethra. *u.c.*, uterine gland complex. *v.s.*, vesicular seminalis.

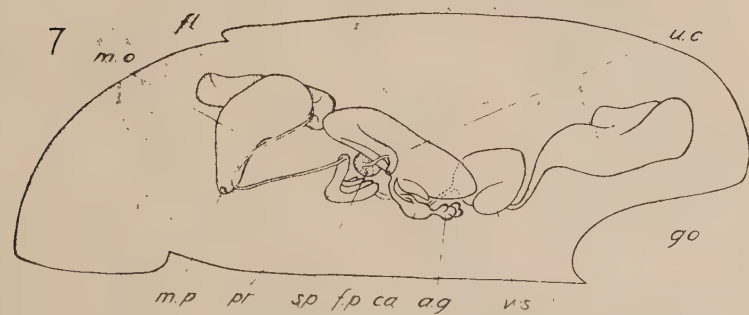
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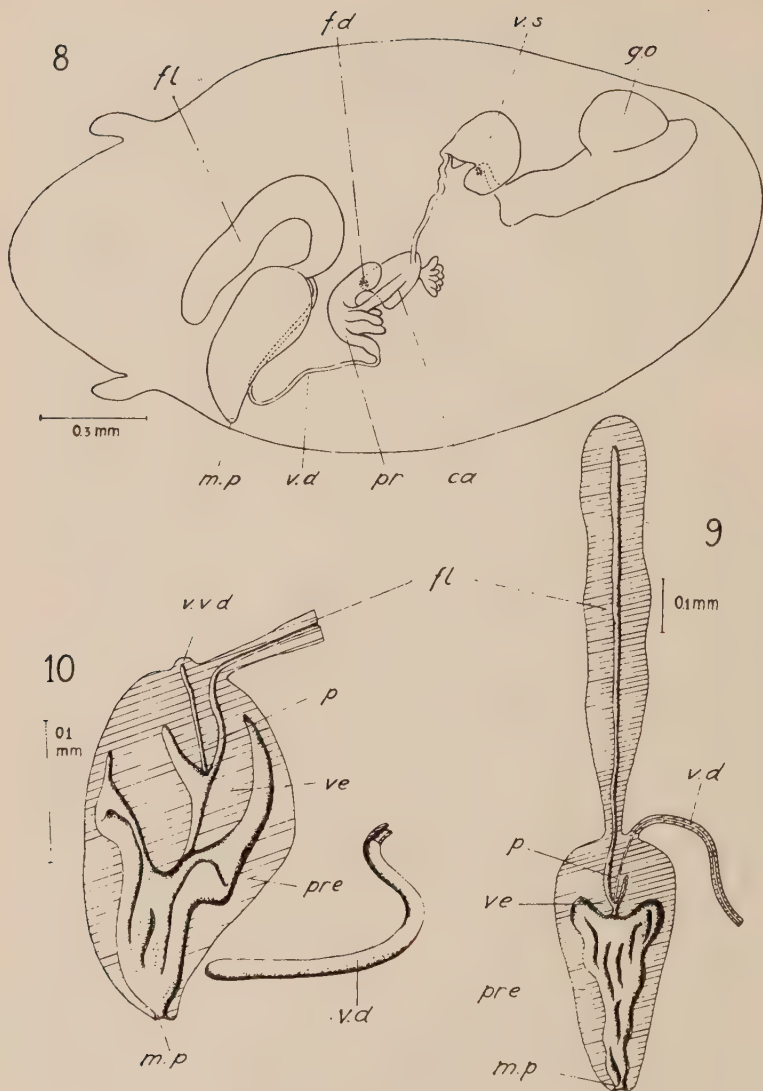


7



Text figs. 5-7.





Text figs. 8-10.

*"Pettancyclus" australicus* (Tate).

8. Diagram of genital system, distal female components removed: dorsal view.
  9. Diagram of longitudinally sectioned male copulatory organ with flagellum.
  10. Diagram of longitudinally sectioned incomplete male organ. Cut surfaces parallel ruled.
- ca., carrefour. fd., beginning of female duct. fl., flagellum. go., gonad. m.p., male genital pore. p., penis. pr., prostate. pre., preputium. v.d., vas deferens. ve., velum. vs., vesicula seminalis. v.v.d., vestige of vas deferens.

The apically located gonad is bifurcated only (text figs. 7-8). In its uppermost parts only eggs are formed, in its lower parts both eggs and spermatozoa. The efferent duct leads to a rather large, thin-walled vesicula seminalis. From there the common duct runs to the carrefour. The albumen gland also joins this structure. From the carrefour the separate male and female ducts go off, the former to the prostate, the latter to the uterine gland complex. The prostate has around five diverticula branching off from a swollen portion of the male duct. The latter continues as the vas deferens to the male copulatory organ, which it enters parallel with the large glandular flagellum. The male organ is not externally divided in a penis sheath and a preputium, but internally there is a dividing velum formation (text fig. 9). The penis is small and has a terminal pore. The lumen of the flagellum continues in the proximal end of the lumen of the penis sheath. In the preputium there are no real muscular pillars, but irregular fold formations. The male genital pore is situated behind the left tentacle.

The large uterine gland complex merges, at its anterior end, into the slender structure which, after joining the thin spermathecal duct, leads to the female pore. This is located on a small papilla below the anterior end of the pseudobranchial flap. The spermatheca is roundish and of moderate size.

In the central nervous system the cerebral and pleural ganglia are fused on either side. This fusion is particularly intimate on the right side. The visceral commissure has three ganglia, of which the middle and left ones are rather diffusely delimited from each other. The pedal commissure is comparatively thin. Behind this is a very slender parapedal commissure.

Before ending this brief description of the topographic morphology in *Pettancylus australicus*, a further note on the aphyall and related conditions in this species may be worth while. As mentioned above, the vast majority of the specimens in the sample examined are aphyallic. Serial sections of one of these specimens show that even here both eggs and spermatozoa are formed in the gonad. Apart from the male copulatory organ also the vas deferens is missing. The prostate is strongly reduced. Of the phallic specimens eight were serially sectioned. In seven of these both eggs and sperm cells were present in the gonad, whereas in the eighth the whole gonad was degenerated. Another sectioned specimen, finally, showed a sort of intermediate state between the phallic and aphyallic condition. In this specimen the whole male copulatory organ was present, but the distal portion of the vas deferens absent (text fig. 10). A little knob on the proximal end of the male copulatory organ indicates the place where the vas deferens should have entered. The remaining distal part of the vas deferens was somewhat swollen, thin-walled and full of spermatozoa. In the same specimen certain parts of the uterine gland complex showed an enormous hypertrophy.

The species under consideration was originally described by Tate as *Ancylus australicus*. The type species of *Ancylus*, *A. fluviatilis* Müller, is, however, anatomically different to an extent that justifies generic discrimination. Iredale (1943) placed the species in his genus *Pettancylus*. However, this genus has never been defined, and its type species, *P. tasmanicus* (Ten.-Woods) has not been anatomically examined. Iredale

separated the "southern" ancylicids from *Ferrissia* without any appropriate reason. "*Pettancylus*" *australicus* has a male copulatory organ which is similar to that of the Indian *Ferrissia tenuis* (Bourguignat) (Hubendick, in press) and probably similar to those of *F. tarda* (Say) (Hoff 1940) and *F. parallela* (Haldeman) (Baker 1928), although differences occur in other organs. However, the type species of *Ferrissia* is *F. rivularis* (Say), and according to my own tentative examination the male copulatory organ is here distinctly different from those in the above-mentioned species. The conclusion to be drawn from this is that it is too early to settle the taxonomic classification of "*Pettancylus*" *australicus*. The same is true for most ancylicids, and the author is slowly collecting information which will enable him to revise the taxonomy of the Ancylicidae.

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# NON-MARINE MOLLUSCA FROM THE FLORIDA ISLANDS, SOLOMON ISLANDS

By ALAN SOLEM, Ph.D.\*

## ABSTRACT.

Land and freshwater molluscs collected on Florida and Tulagi Islands by Robert E. Kuntz in 1943-1945 are reviewed. New species are *Mocella kuntzi*, *Orpiella kuntzi*, *Palaina floridana*, *Palaina clappi*, and *Palaina megamorpha*. Several other species are reported from the Solomons for the first time.

## INTRODUCTION.

Very little is known of the Solomon Island molluscan fauna. Clench (1941: 1-3) summarized the history of early collecting, and references to studies on the marine molluscs can be found in Solem (1953, 1958). Papers on the non-marine fauna are few, those of Smith (1885), Clapp (1923), I. and B. Rensch (1935, 1936), Clench (1951, 1958) and Dell (1955a, 1955c) providing the only data other than scattered species descriptions. Most of these papers cover general collections, the only islands specifically considered being Nissan (Dell, 1955a), the Treasury Group (Dell, 1955c), and Rennell Island (Clench, 1958).

Robert E. Kuntz was stationed on Florida Island from 1943 to 1945. He collected molluscs from sixty localities on Florida and Tulagi Islands (identified by the FLW and ML numbers in the text). A map showing the exact location of each site is on file in the Mollusk Division of the University of Michigan Museum of Zoology. Some stations were in brackish water or marine habitats, and reference to these may be found in Solem (1958).

Prior to Kuntz's work, only eleven species were recorded from Florida Island and three from nearby Tulagi. Kuntz collected thirty-two different molluscs on Florida Island and eight on Tulagi. Five species are new to science, and several genera of minute snails were previously unreported from the Solomons. This reflects the fact that, except for R. K. Dell, no malacologist has collected in the Solomons. Most material has been brought back by missionaries, traders, planters, or vertebrate zoologists who collect only the large, spectacular *Placostylus*, *Papuina*, and *Chloritis*, and ignore the rich fauna of minute species.

Kuntz made even larger collections in the New Hebrides, which were studied at the same time, and are reported on elsewhere (Solem, 1959a, 1959b). Most of his material is deposited at the University of Michigan Museum of Zoology, with some duplicate sets in the Chicago Natural History Museum.

Specimens from several institutions were studied in comparison with Florida Island material. For convenience, the following abbreviations identify the location of material referred to in the text:—

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AMNH	American Museum of Natural History.
ANSP	Academy of Natural Sciences, Philadelphia.
BPBM	Bernice P. Bishop Museum, Honolulu.
CM	Carnegie Museum, Pittsburgh.
CNHM	Chicago Natural History Museum.
MCZ	Museum of Comparative Zoology, Harvard.
UMMZ	University of Michigan Museum of Zoology.

Available data concerning the FLW and ML sites referred to below and in Solem (1958) are given in the appendix. (See p. 53.)

## SYSTEMATIC REVIEW.

### Family Pupillidae.

*Gastrocopta (Sinalbinula) pediculus* (Shuttleworth, 1852).

FLW 38, FLW 40.

### Family Tornatellinidae.

*Lamellidea pusilla* (Gould, 1847).

FLW 40.

Identified by Dr. Yoshio Kondo. Possibly *L. solomonensis* Dell (1955b) is a synonym of the widely distributed *L. pusilla*.

### Family Partulidae.

There is insufficient material in museum collections to evaluate the specific status of the many named Solomon Island *Partula*. They present a uniform appearance of shells 16-17 mm. high, light greenish-horn in colour (sometimes with white bands), and very prominent spiral sculpture. Specimens from the Bismarcks, Admiralties, and Louisiades are very similar to those from the Solomons. The status of the "*Partula*" reported from Western New Guinea is uncertain. The early species named by Lesson have not been rediscovered, while Iredale (1941: 64) created the genera *Scilistylus* and *Amimopina* for other species. *Scilistylus* remains enigmatic, but *Amimopina* is probably an enid. (See Solem, 1959c).

The New Hebridean partulids are usually associated with those from northern Melanesia. The former are quite different, being more than 20 mm. high, with a more elongate spire, much weaker spiral sculpture, and with longitudinal brown streaks on a lighter background. Two New Hebridean species resemble the Solomon Island type (see Solem, 1959b: 71-73), but the others are readily distinguishable.

One Florida Island specimen was identified through comparisons with Hartman's types in the CM.

*Partula coxi* Hartman, 1886.

*Partula coxi* "Angas" Cox, 1868, Exchange List, p. 46, No. 152 (Ysabel Island) (*nomen nudum*); Hartman, 1886, *Proc. Acad. nat. Sci. Philad.*, 1886: 32, pl. 2, fig. 7 (Ysabel Island); Pilsbry, 1909, *Man. Conch.*, (2), 20: 296-297, pl. 36, figs. 1-4.  
FLW 37.

The shell appears inseparable from the holotype of *Partula coxi*, and differs only slightly from *Partula pellucida* (Pease). Possibly both named forms were collected from Ysabel Island, the cited type localities of Hartman often being in error (see Solem, 1959b: 72). Dell (1955c:

428) reported a shell from Mono Island (Treasury Group) which may be the same species as the Florida shell.

### Family Endodontidae.

The Solomon Island species include the large, scalariform endemic genus *Foxidonta* (Clench, 1950), and several quite minute species which have been referred to several different genera. *Endodonta solomonensis* Clapp, *Gyropena nissani* Dell, and a new species are discussed below. Clench (1958: 173-174) recently described two "*Charopa*" from Rennell Island. These species are probably not congeneric with the New Zealand *Charopa*, and may not be endodontids, but rather aberrant paryphantids. The information needed to determine their generic position was not given in the original description, and may be obtainable only from dissection of the soft parts.

*Stenopylis coarctata* (Moellendorff) was discussed fully by Solem (1957). It has an amazingly wide distribution, ranging from Central Australia, the Solomons and New Guinea to the Philippines and Java.

*Mocella solomonensis* (Clapp, 1923). (Plate 4, figs. 1-5).

*Endodonta* (*Charopa*) *solomonensis* Clapp, 1923, *Bull. Mus. comp. Zool., Harv.*, 65: 378, figs. 21-24 (Ugi, Solomon Islands).

Holotype from Ugi, Solomon Islands.

The only known specimen is rather worn, but traces remain of the apical sculpture (Fig. 4), and show that this species belongs to the *Mocella* complex. The original illustrations are not fully satisfactory, and the species has been refigured here, including a greatly enlarged drawing of microsculpture between the major radial ribs (Fig. 5).

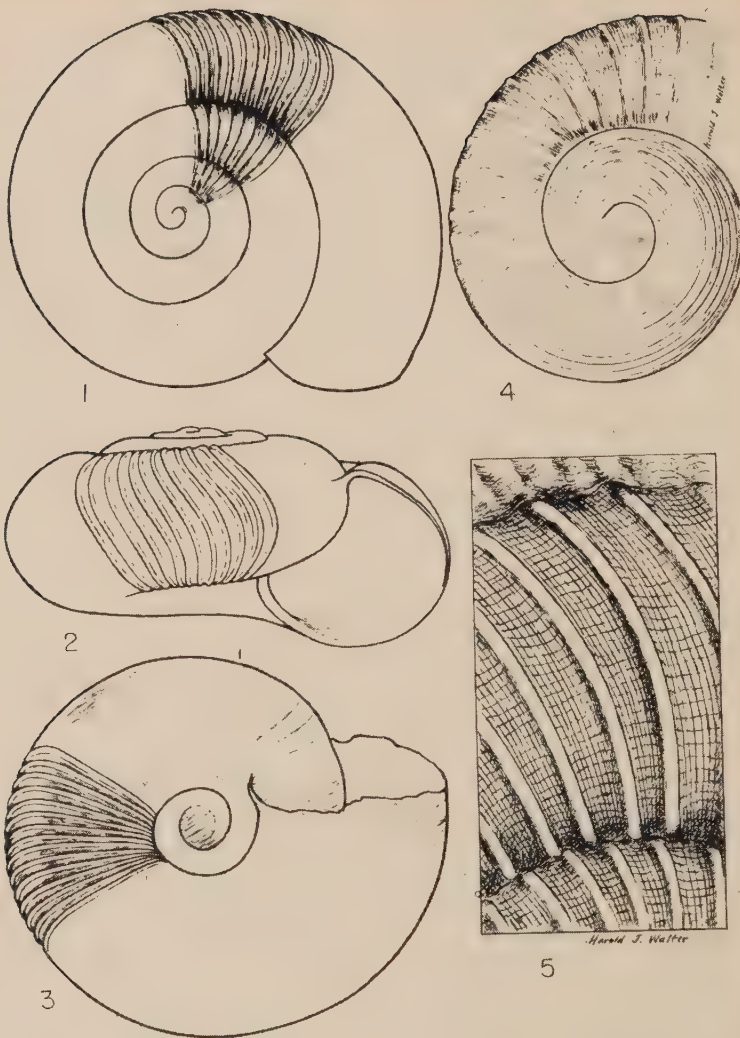
Generic placement of the Pacific endodontids is difficult. A wide ranging group of toothless shells has the same spiral apical sculpture and microsculpture between the ribbing. Many generic names have been applied to this complex, which is found in Polynesia, Melanesia, New Zealand, Australia, and Lord Howe Island. The earliest appears to be *Mocella*, and, until finer distinctions can be made, I'm utilizing this name for the entire series (see Solem, 1959b: 83). The three species discussed here, *solomonensis*, *nissani*, and *kuntzi*, are referred to *Mocella*.

*Mocella kuntzi* sp. nov. (Plate 5, A, figs. 1-3).

*Diagnosis:* A species of *Mocella* separated from *M. solomonensis* by its smaller size (2.0 against 2.8 mm.), more crowded sculpture, and slower rate of whorl increment; from *M. nissani* by its narrower umbilicus and slightly higher shell.

*Description:* Shell minute, depressed-helicoid, spire only slightly elevated. Whorls  $3\frac{1}{4}$  to  $3\frac{3}{4}$ , very slowly increasing in size. Sutures moderately impressed, whorls convex. Aperture ovate, strongly compressed above. Umbilicus deep, open, contained about four times in the diameter. Apical whorls  $1\frac{1}{2}$ , finely spirally ribbed. Spire and body whorl with strong radial ribs (68 on whorls 2-3; 104 on whorls 3-4). Microsculpture of fine riblets crossed by spiral lines between the primary ribs. Colour reddish-brown. Diameter, 1.9-2 mm., height 1.0-1.3 mm.





# PLATE 4.

*Mocella solomonensis* (Clapp). Holotype.

Fig. 1 Top view.

Fig. 2. Side view.

Fig. 3. Bottom view.

Fig. 4. Apical sculpture.

Fig. 5. Microsculpture between radial ribs.

*Type Locality:* Peninsula east of Halavo, Florida Island, Solomon Islands (FLW 38). In leaf mould, November, 1944.

*Types:* The holotype is University of Michigan Museum of Zoology No. 186035. Paratypes from FLW 38 and FLW 40 are UMMZ 186034, MCZ 186827, and CNHM 54905.

*Remarks:* *Mocella kuntzi* is most closely related to *M. nissani* (Dell, 1955a: 328, figs. le-g), but differs in umbilical size. They may be only subspecifically distinct, but at present may best be considered full species. The variation in two lots of *M. kuntzi* is summarized in Table 1.

Table 1.

*Mocella kuntzi*.

	FLW 38 (UMMZ 186034)		FLW 40 (UMMZ 186035)	
	Mean	Range	Mean	Range
Diameter . . . .	2.07	1.90-2.23	2.07	1.94-2.23
Height . . . .	1.16	1.10-1.29	1.11	1.03-1.16
H/D ratio . . . .	0.56	0.53-0.61	0.54	0.49-0.56
Whorls . . . .	3 $\frac{1}{16}$	3 $\frac{1}{2}$ -3 $\frac{3}{4}$	3 $\frac{1}{8}$	3 $\frac{1}{2}$ -3 $\frac{3}{4}$
Umbilicus . . . .	0.50	0.45-0.54	0.53	0.48-0.64
D/U ratio . . . .	4.15	3.84-4.28	3.93	3.46-4.34

All measurements in mm.

*Stenopylis coarctata* (Moellendorff, 1894).

FLW 38, FLW 40.

Family Helicarionidae.

*Liardetia* (*Liardetia*) *samoensis* (Mousson, 1865).

FLW 38.

Ranges from the Bismarcks and New Caledonia east to the Marquesas.

*Liardetia* (*Liardetia*) *nissani* (Dell, 1955).

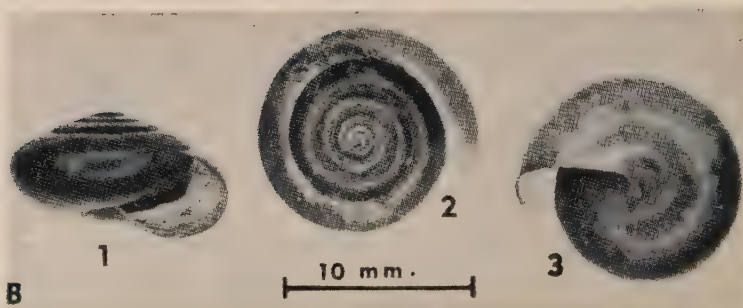
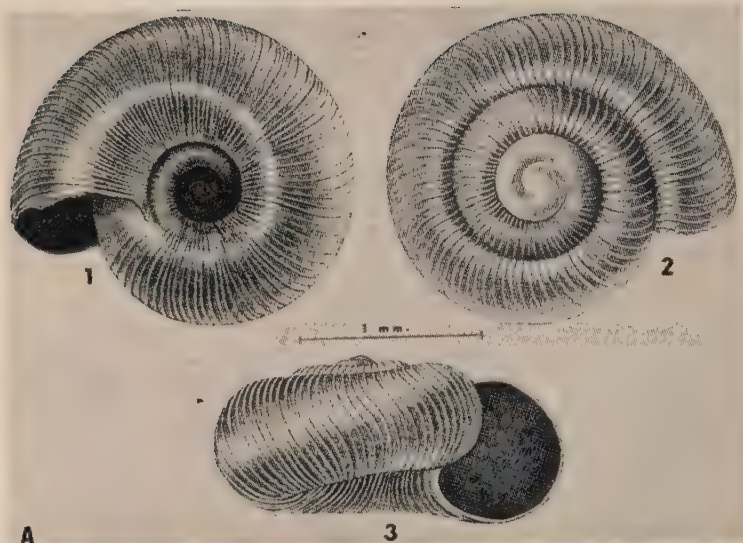
*Orpiella* (*Owaraha*) *nissani*, Dell, 1955, *Pacific Sci.*, 9: 326-327, figs. la-c (Tangalan Plantation, Nissan Island, Solomon Islands).

Through the kindness of Dr. Yoshio Kondo, it was possible to examine a paratype (BPBM 212366). Apparently this species is very closely related to *L. samoensis*, differing only in having less prominent radial sculpture, more crowded spiral sculpture on the base, a slightly slower rate of whorl increment, and a more depressed shape. The differences are all of degree, the sculptural details and general aspect of *nissani* being very similar to *samoensis*. The sculpture and other shell features resemble much more closely *Liardetia* than any *Orpiella*. Pending study of the soft parts, I'm tentatively transferring *nissani* to *Liardetia*.

*Wilhelminaia mathildae* Preston, 1913.

FLW 38, FLW 40.

The same species is found in the New Hebrides (Solem, 1959b: 92-94), and probably ranges through Indonesia.



# PLATE 5.

A. *Mocella kuntzi* sp. nov. Holotype.

Fig. 1. Bottom view. Fig. 2. Top view. Fig. 3. Side View.

B. *Orpiella kuntzi* sp. nov. Holotype.

Fig. 1. Side view. Fig. 2. Top view. Fig. 3. Bottom view.



*Orpiella kuntzi* sp. nov. (Plate 5, B, figs. 1-3).

**Diagnosis:** A species of *Orpiella*, the same size as *O. malaitensis* (Clapp) and *O. treasuryensis* (Tryon), which differs from the former by its less open umbilicus, more reflexed columella, lower spire and more angulated periphery, and from the latter by its much lower spire, greater number of whorls and more angulated periphery.

**Description:** Shell solid, slightly elevated, shining, with faint radiating lines at regular intervals. Whorls  $5\frac{1}{2}$  to  $5\frac{3}{4}$ , regularly increasing in size, sutures slightly impressed, whorls of spire gently rounded, body whorl obliquely angulated above the middle of the whorl, flatter above the angulation, more rounded below. Aperture ovate, slightly compressed laterally, lip slightly thickened. Umbilicus closed apically, but with an umbilical chink partially covered by a reflection of the columellar lip. Parietal callus thin and somewhat opaque. Diameter 13.0-14.0 mm., height 6.8-7.5 mm.

**Type Locality:** One mile in jungle behind Halavo, Florida Island, Solomon Islands at 200 feet elevation (FLW 15). Robert E. Kuntz, collector. October 1, 1944.

**Types:** The holotype is University of Michigan Museum of Zoology No. 184473. Paratypes are UMMZ 184474 (FLW 15) and UMMZ 184475 (FLW 4).

**Remarks:** *O. kuntzi* is perhaps most similar to *O. malaitensis*, but comparison with the holotype of the latter (MCZ 32553) showed the differences mentioned in the diagnosis. References to the previously described Solomon Island *Orpiella* can be found in Clapp (1923: 355-361) and I. and B. Rensch (1936: 654-659).

*Dendrotrochus* (*Dendrotrochus*) *cleryi cleryi* (Recluz, 1851).

FLW 42, FLW 52.

The shells are the same morph that H. B. Baker (1941: 256-257) reported from Three Sisters Island (ANSP 151452). Although Clapp (1923), I. Rensch (1934), Dell (1955c), and Clench (1958) reviewed the Solomon Island *Dendrotrochus*, their taxonomy is still unsettled. Both ecological and anatomical studies are needed before speciation patterns can be discerned.

#### Family Zonitidae.

*Trochomorpha* (*Lentitrochus*) *xiphias floridensis* Clapp, 1923.

*Trochomorpha floridensis* Clapp, 1923, *Bull. Mus. comp. Zool., Harv.*, 65 (11), p. 367 (Florida Island, Solomon Islands).

FLW 4, FLW 15, FLW 21, FLW 23, FLW 24, FLW 26, FLW 29, FLW 30, FLW 32, FLW 35, FLW 52.

*T. x. floridensis* has a higher, more convex spire and a less convex, less inflated base than *T. x. xiphias*. Other material examined from Tulagi (AMNH 70778) and Ysabel Island (MCZ 32518) does not differ significantly from the types (MCZ 32516, MCZ 73674). On Florida Island itself there is considerable variation.

Behind Halavo a peak rises from sea level to 1010 feet. Collections of *T. x. floridensis* from sea level to 500 feet showed a clinal variation in colour pattern, size and whorl count. No collections were made above

500 feet, and the variation from there to the summit remains to be investigated.

Specimens matching the types came from stations 21, 26, 35 and 52. The altitude of FLW 26 is unknown, but the other three lie between three and sixty feet above sea level. The shells are large (average diameter 15.2 mm., range 13.7-17.3, with 5% whorl average). They have a light background colour, two or three narrow spiral red bands above and two below the periphery. The bands are all narrower than their interstices.

Stations 29 and 30 were at about 100 feet elevation. The shells are smaller (average diameter 13.3 mm., range 13.0-13.8, with a 5 whorl average), with a darker background colour, and less prominent red bands which are wider than their interstices.

Shells from stations 4, 15, 21, and 24 were still smaller (station 24, for example, 13 shells average diameter 11.8 mm., range 10.4-12.9, with a 4% average whorl count). FLW 21 was bleached stream drift, but the other stations were 200 to 500 feet in elevation. The shells had a very dark background colour and only faint traces of very wide colour bands.

Material from FLW 23 and FLW 32 was juvenile. The probable cause of this variation is unknown. The genital anatomy of material from FLW 52 differed from that of *T. sanctaeannae* in having the vagina shorter and the talon smaller and less clearly bifurcate. The epiphallus is not sharply separated from the penis, but there is a zone of transition from the narrow pilasters of the epiphallus to the broader ones of the penis. One specimen yielded a small, flat, oval spermatophore.

#### Family Subulinidae.

*Subulina* (*Subulina*) *octona* (Bruguier, 1792).

FLW 16, FLW 42, FLW 43.

*Lamellaxis* (*Allopeas*) *gracilis* (Hutton, 1834).

FLW 38, FLW 40, FLW 42, FLW 43.

#### Family Streptaxidae.

*Gulella* (*Huttonella*) *bicolor* (Hutton, 1834).

FLW 16, FLW 32, FLW 33.

A species widely disseminated by commerce.

#### Family Bulimulidae.

*Placostylus* (*Placocharis*) *kreftii* (Cox, 1872).

FLW 4, FLW 15, FLW 24, FLW 43.

Forty-five specimens of *P. kreftii* were examined. Size and shape varied considerably (see Table 2), encompassing the slender form *artus* and relatively obese shells. The parietal tooth was well developed in most specimens, but was greatly reduced or absent in about one-fourth of the shells.

The relationships of *P. kreftii* are uncertain. Clench (1941) associated it with *P. cleryi* (Petit) in *Eumecostylus*, while others place it with *P. palmarum* (Mousson) and *P. macgillivrayi* (Pfeiffer) in *Placocharis*. The two subgenera are only weakly characterized and they may eventually be combined.

### Family Camaenidae.

Australian workers divide this into a number of families, generally based on shell structure. The Australian genera are no more diverse than the West Indian taxa studied by Wurtz (1955). My own dissections of Pacific species and the anatomical data in the literature provide no criteria justifying family separation of the Pacific and West Indian genera, much less recognition of separate family groupings in the Australian region.

*Eustomopsis customus* (Pfeiffer, 1857).

FLW 4.

*Chloritis quercina* (Pfeiffer, 1857).

FLW 2, FLW 4, FLW 42, FLW 52.

The twenty-five specimens collected by Kuntz belong to the variety *hombroni*. Some populations of this species show intergrades between typical *quercina* and *hombroni* (see Clench, 1958: 197-198), but the Florida Island populations sampled show little variation (Table 2). Typical *quercina* has a H/D ratio of 75-80, while the Florida population averages 61.5.

Clench (1958:198) described *Eustomopsis renschi* from Tulagi Island. It was not collected by Kuntz, but from available data seems to be only an extreme variation of the *quercina* complex. Possibly it is only subspecifically separable.

*Papuina* aff. *caerulescens* (Angas, 1869).

FLW 35, FLM 42.

The two shells have the protractive striae of the *eddystonensis* complex, but the umbilicus is less open, the body whorl more rounded, and the columellar lip broader and flatter than in any described species. *P. caerulescens* appears to be the nearest relative, but the Florida shells have a broader basal lip, less deeply excavated peristome, less angulated periphery, and a different colour pattern. Too little material is available to warrant naming.

*Papuina meta meta* (Pfeiffer, 1856).

FLW 4, FLW 15, FLW 23.

The six specimens are nearest those figured by Pilsbry (1891: pl. 9, fig. 60).

*Papuina meta acmella* (Pfeiffer, 1860).

FLW 4, FLW 35.

Four specimens of this colour form were collected.

*Papuina ambrosia* (Angas, 1867).

FLW 4, FLW 12, FLW 13, FLW 14, FLW 24, FLW 26, FLW 30, FLW 35, FLW 42, FLW 52.

This species is widely distributed in the Central Solomons and was the commonest large snail found by Kuntz. I. Rensch (1934: 4-5) recognised a subspecies, *ramsdeni* Angas, from Choiseul and Florida Islands. The thirty-five adult shells found by Kuntz are much nearer the typical *ambrosia* than the large *ramsdeni* (see Table 2). Different

populations on Florida Island may have been sampled, or the shells seen by I. Rensch were simply the result of a favourable year.

Table 2.

<i>Placostylus</i> , <i>Chloritis</i> , and <i>Papuina</i> .				
		<i>P. kreftii</i>	<i>C. quercina</i>	<i>P. ambrosia</i>
Height	Mean	53.6	21.3	21.9
	Range	48.2-64.0	19.0-24.4	18.0-26.3
Diameter	Mean	21.6	34.6	21.2
	Range	20.1-24.5	29.6-36.7	17.2-25.6
H/D ratio	Mean	2.50	0.62	1.04
	Range	2.26-2.85	0.567-0.651	0.92-1.27

#### Family Planorbidae.

*Gyraulus* (*Pygmanisus*) *corinna* (Gray, 1850).

ML 100.

Most of the specimens were relatively small (1.65 mm. in diameter with 2½ whorls). The largest individual (2.22 mm. in diameter with 3¼ whorls) was identical with typical Fijian specimens ("*singularis* Clessin") and smaller Tasmanian ("*scottianus* Johnston") and New Zealand ("*corinna* Gray") shells. The minute planorbid snails vary greatly under differing ecological conditions, and it is not impossible that the above names refer to only one widely distributed species. Rather than add to an overburdened taxonomy, I have utilized the oldest available name for the Solomon shells.

#### Family Helicinidae.

I. and B. Rensch (1936: 679-683), Dell (1955a, 1955c) and Clench (1958: 159-164) provide recent records for Solomon Island helicinids. The identity of the shell that Dell (1955c: 426) reported as *Geophorus agglutinans* (Sowerby) is puzzling. *Geophorus* is a Philippine-Indonesian genus, and *G. agglutinans* a common Philippine species. Its occurrence in the Solomons would be most unexpected. Possibly this record is based on specimens of *Pleuropoma sophiae* (Brazier), which was described from the Treasury Islands, and is somewhat similar to *G. agglutinans* in shape and colour.

*Palaeohelicina egregium* (Pfeiffer, 1855).

FLW 4, FLW 8, FLW 11, FLW 13, FLW 14, FLW 24, FLW 26, FLW 30, FLW 32, FLW 35.

There is considerable variation in the colour banding of this common species. All specimens had a single red spiral band just below the keel, which varied in width from one to two millimeters. Many had a lighter, wider band above the periphery midway between the keel and suture.

Typical *egregium* is known from the Florida group, Malaita, and Stirling Islands. I. and B. Rensch (1936: 679) and Clench (1958: 162)



report *P. moquiniana* (Rechiz) from Tulagi, but all the Kuntz specimens from Tulagi (FLW 8, FLW 11) were *P. egregium*.

*Sturanya modesta* (Pfeiffer, 1853).

FLW 26, FLW 29, FLW 30, FLW 32, FLW 38.

The original locality of *S. modesta* was given as Tanna, New Hebrides. E. A. Smith (1885: 598-599) established the identity of the types with the Solomon Island species. No helicinid resembling *modesta* is found in the New Hebrides (Solem, 1959b: 178), and circumstantial evidence suggests that the locality is erroneous, the type localities of a New Hebridean *Pupina* and *S. modesta* having been switched in manuscript.

Solem (1959b: 168) accepted the type designation of H. B. Baker (1922: 43) for *Sturanya*, which led Pilsbry and Cooke (1934) to propose a substitute name, *Sturanyella*. H. B. Baker (personal letter) called my attention to an overlooked type designation by Kobelt in a review of Wagner's studies. The type of *Sturanya* Wagner, 1905 is *Helicina plicatilis* Mousson by subsequent designation of Kobelt (1905: 207). *Sturanyella* thus becomes an objective synonym of *Sturanya*.

#### Family Pupinidae.

*Pupina* (*Pupina*) *keradreni* Vignard, 1829.

FLW 16, FLW 21, FLW 30, FLW 33, FLW 40, FLW 44, FLW 46.

Clench (1949: 31-33 and 1958: 166) maintained that *P. solomonensis* and *P. keradreni* are distinct species. This was questioned by Dell (1955c: 424), and Kuntz's collections do not support the separation. The two differ primarily in size, *P. keradreni* being 6.5-6.6 mm. high, and *P. solomonensis* 7.3-7.4 mm. high. Kuntz's twenty-five adult shells ranged from 6.1-7.5 mm. Twelve specimens were 6.8-7.0 mm. high, and one lot, FLW 44, contained shells 6.2, 6.4, 6.6, 6.7, 6.8, 6.9, 7.1, and 7.5 mm. high. The Florida and Tulagi populations are thus intermediate between *keradreni* and *solomonensis*. In the MCZ collection, typical *keradreni* is present from Ysabel, Rennell, Malaita and San Cristoval; typical *solomonensis* from Shortland and Choiseul; and intermediate sized shells from Florida and Tulagi. The relationship of the named forms is thus uncertain, but the problem requires more data than is available.

#### Family Cyclophoridae.

*Leptopoma* (*Dermatocera*) *perlucidum* (Grateloup, 1840) (= *vitreum* Lesson, 1831, not Draparnaud, 1801, and *nitidum* Sowerby, 1843).

FLW 15, FLW 20, FLW 45.

Generally this species is referred to as *vitreum* or *nitidum*, but I follow Forcart (1952) in accepting *Cyclostoma perlucida* Grateloup, 1840 as the earliest name for this species which is available.

#### Family Diplommatinidae.

Prior to this study, five diplommatinids were known from the Solomons—*Diplommatina brazieri* and *D. wisemanni* (Cox, 1870) from San Cristoval, and *D. aerari*, *D. solomonensis* and *Palaina gardneri* (Dell, 1955c: 424-425) from Mono Island, Treasury Group. Cox's species are unfigured and too vaguely described for comparison with the others. *Palaina gardneri* and *Diplommatina solomonensis* are dextral, and only *D. aerari* could be confused with the species described below. It is

readily distinguished by being 3.91 mm. high and having a weak tooth on the columellar lip.

Kuntz collected three species from leaf mould in the area behind Halavo (FLW 18). Their generic reference is uncertain. By definition, *Palaina* has no columellar tooth and *Diplommatina* a strong tooth on the columellar lip. All three Florida Island shells have a columellar tooth deeply recessed within the aperture. Study of specimens in the UMMZ and CNHM revealed that *Palaina taeniolata* Quadras and Moellendorff from Guam, Mariana Islands has a similar recessed tooth. Probably this character has developed several times in the diplommatinid stock, and the Florida species are provisionally referred to *Palaina*.

The three species are easily separable. *Palaina floridensis* is minute (height 2.11 mm.), has a relatively strong recessed columellar tooth and a circular thickened peristome; *P. clappi* is small (height 2.52 mm.), has a moderately developed recessed columellar tooth and a subquad-rangular peristome closely appressed to the penultimate whorl; and *P. megamorpha* is large (height 4.51 mm.), has a weak recessed columellar tooth and an only slightly expanded peristome with a thin parietal callus.

Size variation in the three species is summarized in Table 3.

Table 3.

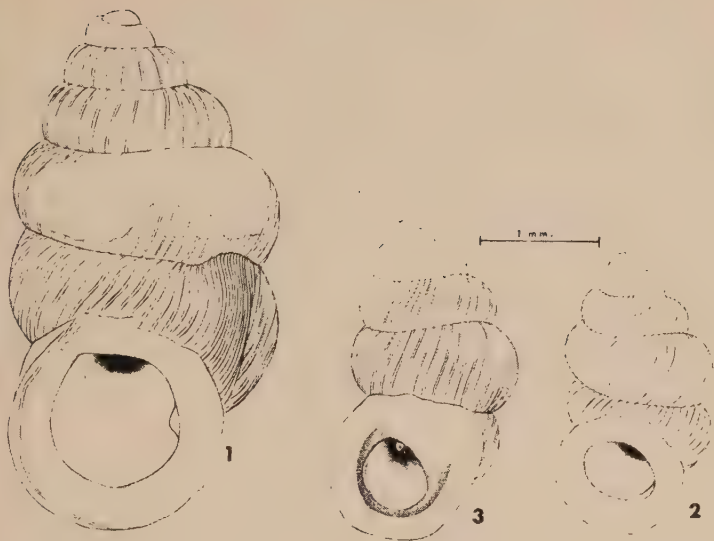
*Palaina.*

	<i>P. floridensis</i>	<i>P. clappi</i>	<i>P. megamorpha</i>
No. of specimens	17	4	1
Height of shell			
Mean	2.11 mm.	2.52 mm.	4.51 mm.
Range	1.96-2.26	2.48-2.59	
Diameter of shell			
Mean	1.24 mm.	1.64 mm.	2.32 mm.
Range	1.14-1.33	1.61-1.67	
H/D ratio			
Mean	1.70	1.54	1.95
Range	1.55-1.84	1.49-1.61	
Whorls			
Mean	5%	4%	6%
Range	5½-5%	4½-5	

*Palaina floridensis* sp. nov. (Plate 6, fig. 2).

*Diagnosis:* A minute *Palaina* with 4½ whorls, a prominent columellar tooth deeply recessed within the aperture, a circular thickened peristome slightly elevated above the penultimate whorl and the body whorl over-riding three-fourths of the penultimate whorl.

*Description:* Shell minute (height 1.96-2.26 mm.), sinistral, ovate-cylindric. Colour light brown. Whorls 5¼ to 5%, sutures deeply impressed, later whorls tumescent. Body whorl slightly constricted behind, over-riding about three-fourths of the penultimate whorl. Apical whorls 1½ with weak, slightly protractive radial ribs. Remaining whorls with prominent, regularly spaced protractive radial ribs and a few fine spiral lines between the ribs. Aperture circular, with broadly expanded circular peristome slightly free of penultimate whorl. Strong columellar tooth deeply recessed within aperture. Operculum without calcareous elements, large, deeply concave, with central nucleus.



# PLATE 6.

Fig. 1. *Palaina megamorpha*. sp. nov. Holotype.

Fig. 2. *Palaina floridensis*. sp. nov. Holotype.

Fig. 3. *Palaina clappi*. sp. nov. Holotype.

*Type Locality:* In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

*Types:* The holotype is University of Michigan Museum of Zoology No. 181756. Paratypes are UMMZ 200494, CNHM 55208, and BPBM 212386.

*Remarks:* This was by far the commonest of the three species. Several individuals were collected alive and the operculum was "glued" to the aperture by the dry animal.

*Palaina clappi* sp. nov. (Plate 6, fig. 3).

*Diagnosis:* An average sized *Palaina* with  $4\frac{1}{4}$  to 5 whorls, a moderately developed recessed columellar tooth, a subquadrangular thickened peristome closely appressed to the penultimate whorl, and the body whorl over-riding the penultimate and one-third to one-half of the antepenultimate whorl.

*Description:* Shell of average size for the genus (2.5 mm. high), sinistral, ovate-cylindric. Colour very light brown or white. Whorls  $4\frac{1}{4}$  to 5, sutures deeply impressed, later whorls moderately swollen. Body whorl strongly contracted behind, over-riding penultimate whorls and one-third to one-half of the antepenultimate whorl. Apical whorls  $1\frac{1}{4}$ ,

with weak, slightly protractive radial ribs. Remaining whorls with stronger, almost regularly spaced, protractive radial ribs. Aperture circular, flaring, peristome subquadrangular, closely appressed to antepenultimate whorl at point of attachment. Aperture with moderately developed, deeply recessed columellar tooth. Operculum without calcareous elements, deeply concave, large, without central nucleus.

*Type Locality:* In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

*Types:* The holotype is University of Michigan Museum of Zoology No. 181755. Paratypes are UMMZ 200495, CNHM 55207, and BPBM 212385.

*Remarks:* The strongly constricted body whorl and sharp ascension of the aperture on the spire recall some of the Bismarck Island *Palaina* (see I. Rensch, 1937), but size and whorl count easily separate *P. clappi*. This species is named after William F. Clapp, who published an important paper on the Solomon Island fauna (Clapp, 1923).

*Palaina megamorpha* sp. nov. (Plate 6, fig. 1).

*Diagnosis:* A large species of *Palaina* (4.51 mm. high) with 6½ whorls, a weak columellar tooth deeply recessed within the aperture, a very slightly expanded peristome, and the body whorl over-riding about one-half of the penultimate whorl.

*Description:* Shell large (4.51 mm. high), sinistral, subturritiform. Whorls 6½, sutures impressed, later whorls moderately swollen. Body whorl slightly constricted behind, over-riding to mid-point of penultimate whorl. Apical whorls 2, slightly elevated, worn. Remaining whorls with regularly spaced protractive ribs. Aperture circular, peristome only slightly expanded and thickened, reduced to a thin callus on parietal wall. Weak columellar tooth deeply recessed within aperture. Operculum not seen.

*Type Locality:* In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

*Type:* The holotype is University of Michigan Museum of Zoology No. 200493.

*Remarks:* Possibly the only specimen seen is juvenile, and the apertural characters are greatly modified in adult shells. The size and whorl count separates this shell from any other Melanesian Diplommatinid and makes nomenclatural recognition advisable.

#### Family Truncatellidae.

*Truncatella* (*Taheitia*) aff. *scalariformis* Reeve, 1842.

FLW 32.

The single specimen is nearest to this form, but not identical.

#### Family Assimineidae.

*Pseudocyclotus levis levis* (Pfeiffer, 1855).

FLW 18, FLW 29, FLW 30, FLW 32, FLW 46.

All specimens were juvenile, about 2.5-3 mm. in height, but corresponded well in sculpture and operculum to adult shells in museums.



*Omphalotropis* (*Omphalotropis*) *nebulosa* Pease, 1872.

FLW 35, FLW 38, FLW 40, FLW 44.

*Setaepoma mayri* Clench, 1958.

*Setaepoma mayri* Clench, 1958, *Nat. Hist. Rennell Id.*, 2: 167-168, fig. 1, pl. 17, fig. 5 (Fulakora, Ysabel, Solomon Islands).

FLW 10.

Identification of the single juvenile specimen was confirmed by W. J. Clench. The genus *Setaepoma* (Clench, 1955) is based on *Japonia hedigeri* I. and B. Rensch (1936: 678-679, fig. 25) from Guadacanal. New Guinea species, for which Iredale (1941: 58) provided the generic names *Dominamaria*, *Memonella*, and *Atrocyclus*, are apparently closely related, as may be *Mychopoma exul* Moellendorff, 1897 from Constantin-haven and *M. pennatum* van Benthem Jutting (1958: 311-313, fig. 7) from Misool. All may belong to one generic unit, but more study is needed before any opinion can be given.

#### APPENDIX.

Collection stations of Robert E. Kuntz on Florida and Tulagi Islands.\*

\*Only those cited above or in Solem (1958).

ML 100. Small pool in Taro Swamp, 10-16 in. deep, 100 feet from mangroves. "MacFarlands Water Hole". January 11, 1945.

FLW 2. Swampy area near mangroves, Halavo, Florida Island. Sept. 26, 1944.

FLW 4. Around fallen trees and rocks, 300-500 feet elevation, Florida Island. October 1, 1944.

FLW 5. Rocks at edge of semi-permanent stream, south-west side of Tulagi. Sept. 15, 1944.

FLW 6. On rocks in swiftly flowing water near FLW 5. Same date and data.

FLW 8. Wet broad leaf vegetation in ravine, south-west Tulagi. Sept., 1944.

FLW 10. Behind Halavo, Florida Island.

FLW 11. Small stream south side of Tulagi. Sept., 1944.

FLW 12. Mangroves or shrubs in swamp behind Halavo, Florida Island.

FLW 13. On trees, shrubs and ground behind Halavo, Florida Island. Oct., 1944.

FLW 14. In leaves on hillside behind Halavo. Oct., 1944.

FLW 15. Ground debris, 200 feet elevation, one mile behind Halavo, Florida Island. Oct. 1, 1944.

FLW 16. Under British Residency, Tulagi. 250 feet elevation. Oct., 1944.

FLW 17. Freshwater stream in sago palm swamp, Turner City, Florida Island. Sept., 1944.

FLW 18. Leaf mould, 30 feet from stream bank, elevation 60 feet, one-half from sea behind Halavo, Florida Island. Oct. 22, 1944.

FLW 20. Under edge of hut at Halavo, Florida Island. Oct. 22, 1944.

- FLW 21. Same as FLW 18.
- FLW 23. From ground in low area one-quarter mile behind Halavo, Florida Island.
- FLW 24. On dead logs, decaying leaves, damp rocks in shade, three-quarters mile behind Halavo, Florida Island. Elevation 300 to 500 feet, thick jungle with south-east exposure. Oct. 1, 1944.
- FLW 26. On broad-leaf plants in jungle, Halavo, Florida Island. Oct. 22, 1944.
- FLW 28. Same as FLW 26, but during night.
- FLW 29. From shrubs and a dead tree trunk, one-half mile from beach at 100 feet elevation behind Halavo, Florida Islands. Oct. 23, 1944.
- FLW 30. Under forest debris near stream, one-half mile behind Halavo, Florida Island. Oct 22, 1944.
- FLW 32. Slopes of a small stream north of Halavo, Florida Island. Nov., 1944.
- FLW 33. Under dead leaves on "Radar Hill", 170 feet elevation, Florida Island. Nov., 1944.
- FLW 34. Pool 4-8 in. deep, 50 yds. from mangrove swamp near Hagalu, Florida Island.
- FLW 35. Ground debris in plantation, on vegetation one to four feet above ground, peninsula east of Halavo, Florida Island. Nov., 1944. Elevation three feet, 20-100 feet from beach.
- FLW 37. Same as FLW 34.
- FLW 38. Peninsula east of Halavo, Florida Island. Nov., 1944. Under debris.
- FLW 40. Soil samples from peninsula east of Halavo, Florida Island.
- FLW 42. On ground in heavy jungle near Hugutambu River, Florida Island. Jan., 1945.
- FLW 43. Under planks on "90 mm. Hill", Tulagi. In grassy, semi-open area.
- FLW 44. Rotten sago palm trunk, 8-10 in. down in wet debris, south-west Tulagi.
- FLW 45. On ginger leaves in deep shade, three feet above ground, Kokemtambu Island. Jan., 1945.
- FLW 46. Under side of leaves at Hagalu, Florida Island. Jan., 1945.
- FLW 47. On sand and logs. along beach at low tide.
- FLW 48. In mud or on roots in mangrove swamp, west end of Tulagi. Dec., 1944.
- FLW 50. On mud flats or mangrove roots at low tide, Tulagi. Feb., 1945.
- FLW 51. On debris in water in mangrove swamp, Hagalu, Florida Island. Feb., 1945.
- FLW 52. Piles of fallen leaves and fronds in sago palm forest on Florida Island opposite west end of Tulagi. Jan., 1945.
- FLW 54. Food pile in Haleta Village, Florida Island. Feb., 1945.

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## THE OCCURRENCE OF A NEMATODE PARASITE IN THE GENUS *STYLODON*

By RUTH D. TURNER, Ph.D.,\* and MADELINE A. PINI, B.A.†

Little is known concerning the presence of nematodes in molluscs, although molluscs have long been suspected of being intermediate hosts for nematodes parasitic in vertebrate animals such as sheep, cats and chickens. Previously, it has been the nematologists who were concerned with this problem, and the literature is found principally in the journals of parasitology. Chitwood (1937) and Mengert (1953) have summarized the present knowledge about the occurrence of nematodes in molluscs. Mengert reported that an examination of 1300 snails revealed 30 species of roundworms. This work was done in Germany on native material, mostly slugs. Chitwood and others have reported nematodes infesting several genera of molluscs including *Opeas*, *Helix*, *Polygyra*, *Anguispira*, *Succinea*, *Cepaea*, *Hygromia*, *Helicigona*, *Theba*, *Monacha*, and *Helicella* among the land snails, and *Lymnaea*, *Planorbis*, *Viviparus*, *Physa*, and *Bythinia* among freshwater snails. Nematodes may occur in molluscs accidentally, as parasites living their entire life cycle in the snail or as juveniles spending part of their life cycle there. It is this last group with which we are particularly concerned, for it contains species of economic importance.

Gerichter has done considerable experimental work on the life cycle of lung nematodes of sheep and cats, and has shown conclusively that at least five species of lung nematodes are dependent upon molluscs for their intermediate hosts.

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Text fig. 1.

Sketch of the animal of *Stylodon unidentata globata* v. Marts., with the shell removed, showing the location of the nematodes.

Most work of this kind has been done in areas of high population such as India and the Near East, but for much of the world the details of the mollusc-nematode relationship are unknown.

During the 1958 Yale University Expedition to the Seychelles Islands, a small collection of land shells was made, and we have been privileged to report upon this material.

While dissecting *Stylodon unidentata globata* v. Marts., we were surprised to find numerous encysted juvenile nematodes in the pulmonary cavity (Text fig 1, Plate 1, 1-2). A survey of the literature showed this to be an unusual site of infestation. Most molluscan nematodes are reported as occurring in the digestive tract or in the foot.

We immediately checked all the specimens in this lot, a series of fourteen specimens from Bois Teck, Silhouette Island, Seychelles, taken at an altitude of 800-1600 feet. Of these, six were found to be infested, with the degree of infestation ranging from one or two worms to one hundred or more per specimen. Although a careful examination was made of the entire animal, the worms were found only in the mantle cavity. Both adult and young snails were infested. A check was made of the preserved specimens of *Stylodon unidentata* Chem. and *Stylodon studeriana* Fér., but no worms were found.

Since these worms are juveniles, it has been impossible to make a positive determination. Dr. Nathan Reiser, of Northeastern University, who examined the worms, suggested that since some of the cysts appeared to be in the process of disintegration, this snail was perhaps not the normal host; this remains to be seen. Further material is needed.

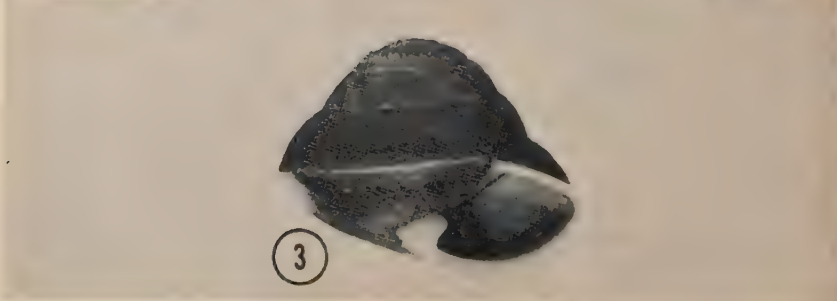


PLATE 7.

M. B. Chitwood, of the United States Department of Agriculture, who kindly consented to examine the worms, confirmed the authors' suspicions that the nematodes are probably members of the larval lung-worms of the *Metastrongyloida*. The adults of this group parasitize mammals. Specimens of the worms have been deposited in the United States National Museum (U.S.N.M. Helm. Coll. No. 56678).

Very little is known of any nematodes from these islands, the animals which they infest, or their relationship to the roundworms of Africa and Asia. The problem is one that concerns both malacologists and parasitologists. It is here that shell collectors, both amateur and professional, can be of great assistance. As several writers have pointed out, thousands of animals may be examined in vain by the eager nematologist, while the unsuspecting malacologist innocently throws away the soft parts of the snails, and with them the precious nematodes.

A few minutes spent in examining the animal will prove not only helpful to the parasitologist, but also interesting for the collector. If one suspects that he has an infected animal, it should be placed in 75% alcohol and sent with a specimen of the shell to the authors, who will see that it is forwarded to the nematologist mentioned above.

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#### PLATE 7.

*Stylodon unidentata globata* v. Marts.

1. Encysted nematode in the wall of the pulmonary cavity. 90x.
2. Section of nematode-bearing tissue from the pulmonary cavity. 20x.
3. The infected snail (MCZ No. 225927). Natural size.

# VARIATIONS IN AN AUSTRALIAN HALIOTID, *HALIOTIS COCCORADIATA* Reeve, 1846

By R. R. TALMADGE.\*

For a number of years malacologists have commented on the variation in the sculpture and colouration of *Haliotis coccoradiata* Reeve, 1846, inhabiting the south-eastern coast of Australia. In this summary the genus *Haliotis* is used in the broadest sense (*sensu lato*), as anatomical evidence suggests that our present classification at the generic level needs revision. Rather than digress into a study of the higher classifications on a study restricted to a single species, the well-known *Haliotis* will be used.

As a number of specimens were available to the writer, from localities that could be plotted on a large scale map, it was thought that perhaps some answer might be found for the variations which had been observed. The following notes are the result of this comparative investigation.

Eighty specimens were made available for examination, as well as those in the collections of the museums and universities on the coast of California. However, the basic study is restricted to the eighty specimens, ranging from 10 mm. to 60 mm. major diameter, eleven of which contained the soft parts for comparison and dissection. The majority of these specimens were taken within a few miles of Sydney, thus presenting a good representation of this population of the species. Series such as these give a much clearer concept of the species, as the age stages, pathological specimens, and colour variations are more readily identified as such. The animal in combination with the shell presents a check on the possible separation at a species level, as well as providing a means of determining if sexual differences cause variation in the shell.

Nearly all the specimens had a similar shape, regardless of age stages, so the shape of the shell was ruled out for comparative purposes.

Other than colouration, there were found to be two distinct and notable variables: the number of open siphonal pores (which is given great status by Reeve (1846a); and the sculpture.

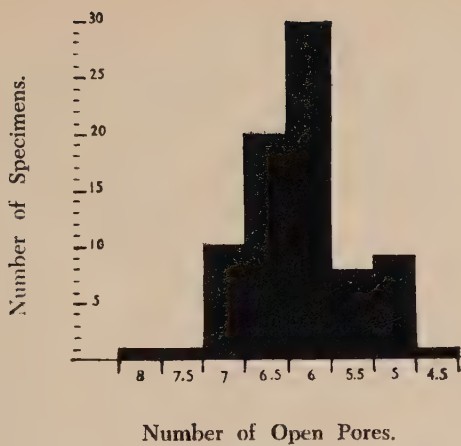
*Open Siphonal Pores:* In the series examined, the number ranged from  $4\frac{1}{2}$  to eight, with sixty (75%) of the specimens having 6 to 7 (Text fig. 1). The number of orifices could not be attributed to age stages, as both the smallest and largest specimens had six each. The evidence indicates that the number of such openings is dependent upon the individual animal.

*Sculpture:* This was found to exhibit considerable variation, which could not be correlated with any age stage. The shell, in most cases, is covered with a series of rather uniform cords, which under a strong glass, give a scale-like appearance. There are low rounded wrinkles, radiating from the suture in the upper third of the body whorl.† The chief variation is in the cording, which may be divided into four types and which merge from one into the other (Text. fig. 2). The most common

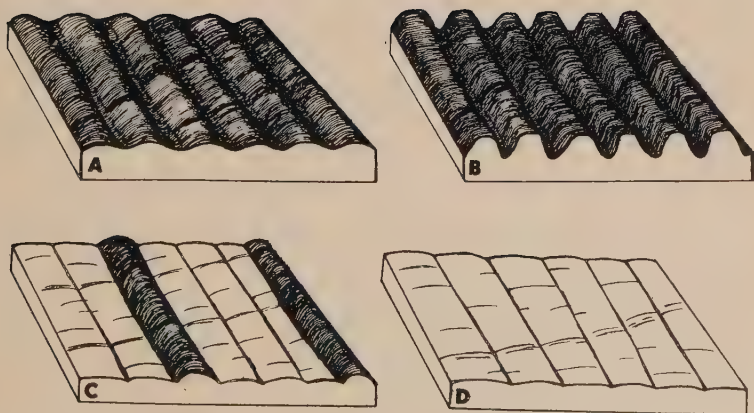
†One example was noted to have these wrinkles developed into actual lamellae, but this shell was pathological in other features also.

\*Willow Creek, California, U.S.A.





Text fig. 1.



Text fig. 2 (Diagrammatic).

Types of sculpture.

(Text fig. 2 A) was a rather uniform, rounded thread, more or less equally spaced across the shell. This blended into the second type (Text fig. 2 B), which had enlarged and sharply defined cords. These enlarged cords were quite striking, and gave the specimens almost a separate specific appearance. The third type (Text fig. 2 C), a much less common sculpture, consisted of a single, rather coarse cord, widely spaced on a nearly smooth shell surface. Under a glass, obsolete cording could be seen in the semi-smooth areas. The fourth type (Text fig. 2 D) was a nearly smooth surface which gave no indication of wear or erosion, only obsolete striae. These last two types of sculpture, like the coarsely corded form, were quite notable. This was true in the specimens that had the sculpture in the pure form, but the numerous intermediate shells formed a perfect intergradational series.

*Colouration:* This varies so much that it would be impossible to describe in any detail the numerous phases. As the colour charts of Ridgeway and others are not available to all students, only general terms will be used. It was found that no two specimens were alike. The basic colours were a rich red-brown, white, cream, or light green. These were boldly splotted over the surface of the shell, the radiating markings shown in the original illustrations not being found in many cases. Some specimens, instead of having the bold maculations, had the colouration subdued and blurred into more or less pastel tints. A few specimens were nearly concolour.

The various series were then sorted as to locality in an effort to co-ordinate the colouration, sculpture and number of open pores, to a localized ecological condition. It was found that regardless of the collecting station, these same variations occurred in all series.

The animals were examined to learn if sex, as determined by the colour of the gonad, should be used as a factor to correlate the variations observed in the shell. The answer was negative. From the study of the epipodium, *H. coccoradiata* may be placed into the major groupings of the haliotids. This is separable from the minor anatomical groupings of *H. asinina* Linné, *H. cyclobates* Peron and *H. sanguinea* Hanley; that is, the animal may be contained within the shell, the epipodium forms a nearly continuous fleshy girdle encircling the foot, and has both an upper and lower rim. The thickened area between the rims is processed. No two species are alike in this group, but all have a general similarity.

The data thus indicate that *H. coccoradiata* is a quite variable species in the number of open pores, cording and shell colouration. The animal remains constant. These variations cannot be explained as the result of age stages, sexual or localized ecological conditions. The only remaining cause would be on the individual genetic basis. A similar situation exists in the Canary Islands, where a single species also exhibits similar variations (Talmadge, 1958).

To validate the identification of certain material, selected specimens and some series were sent to the British Museum (Natural History) for comparison with the original material used by Reeve in the Hugh Cuming Collection. The basic and most common specimens matched the named series, while the coarsely corded specimens fit into the type lot of *H. lauta* Reeve, 1846. The original description of this last species placed the range in Western Australia. *H. lauta* Reeve has been placed as a synonym

of *H. semiplicata* Menke, 1843, by some authors. These recent comparisons now leave the status of *H. lauta* open to further study.

The writer wishes to express his deep appreciation to Dr. D. F. McMichael, of the Australian Museum, Sydney; Mr. S. P. Dance, of the British Museum (Natural History); Dr. Leo Hertlein, of the California Academy of Sciences, and Dr. Myra Keen, of the Stanford University, California, as well as to the many private collectors in Australia who assisted with specimens, literature and field data. Without this co-operation and assistance, this portion of the general study of the haliotids could not have been carried out.

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ON *TYLODINA CORTICALIS* (Tate). A RARE  
OPISTHOBRANCH FROM SOUTH-EASTERN AUSTRALIA

By ROBERT BURN.\*

*Tyloдина corticalis* (Tate 1889, pp. 65-66) is a rare south-eastern Australian opisthobranch gastropod. Its discovery in the living state is unusual; the time of the year during which it has been found alive (March-April) apparently corresponding to the breeding period. It has a vertical range from the littoral and sub-littoral to 7-16 fathoms (Tate, loc. cit.) to 30 fathoms (Bass Strait trawlings: specimens in the collection of Mrs. D. I. Hartley, Melbourne).

The recent finding of two living specimens allows a fuller description of both shell and animal to be compiled. The writer must express his thanks to Miss F. V. Murray, of Melbourne, for making available the larger of the two specimens, and to Miss J. H. Macpherson, National Museum of Victoria, Melbourne, for the loan of a series of kodachrome slides made from this specimen while alive.

*TYLODINA CORTICALIS* (Tate, 1889).

*Umbrella corticalis* Tate 1889, p. 65, pl. 11, fig. 11.

*Umbraculum corticalis* Cotton and Godfrey. 1933, p. 97, pl. 1, fig. 22.

*Umbraculum corticalis* Macpherson and Chapple 1951, p. 140.

*Tyloдина corticalis* Burn 1959, p. 28, fig. d.

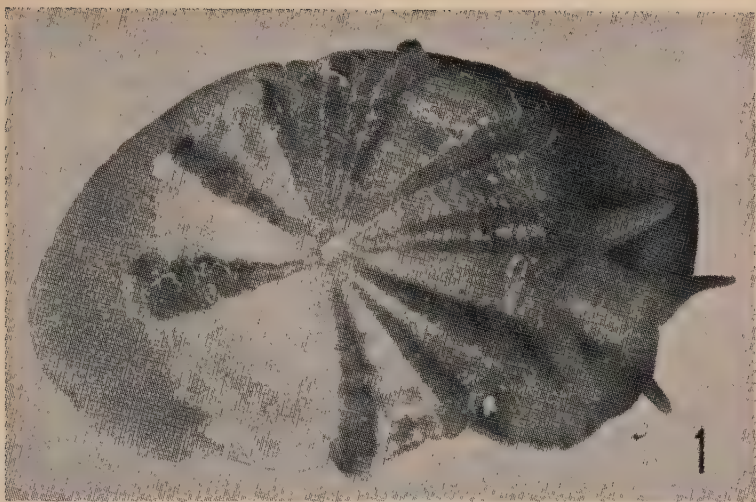
The larger living specimen (Text fig. 1) was 50 mm. long, about 35 mm. broad, and 12 mm. high; preserved it is 20 mm. long, 15 mm. broad, and 10 mm. high. The smaller specimen alive was 22 mm. long, 11.5 mm. broad, and 5 mm. high; preserved it is 10.5 mm. long, 8 mm. broad, and 5.5 mm. high. The shell covers only the gill, the basal parts of the rhinophores and the body or visceral hump; the foot protrudes in front and behind; the head with the eyes and oral tentacles extends forward over the anterior foot.

The whole animal is either ochraceous yellow or brilliant lemon yellow. The interstices of the foot patterning are whitish; the anterior edges of the foot, the rhinophores and the skin over the pharyngeal bulb are orange. The mantle is pale creamy-yellow, darker at the margins. The sides of the body are white; the gill is yellow. In both alcohol and phenoxotol preservatives, the yellow pigment of the skin precipitated, and the animals are now drab blue-gray or purple; this corresponds to Tate's statement (1889, p. 66) that the "animal is of a deep port-wine colour".

The shells (Text figs. 4, 5) are very broadly oval in shape and nearly flattened. Inclusive of the periostracum they measure respectively 29 x 25 x 3.5 mm. and 12.5 x 11 x 2.7 mm. in length, breadth and height. The shell proper in each case measures 19 x 16 x 2 mm. and 8.5 x 7 x 1.3 mm., and is very thin and fragile with razor-sharp edges. The corneous periostracum is thin about the protoconch and thick at the margins; it spreads completely over the shell and extends well beyond it, but not as far as Tate (loc. cit. p. 65) indicated. There are thirteen radial ridges on the larger shell and eleven on the smaller one; Tate (loc.

\*34 Autumn Street, Geelong West, Victoria, Australia.



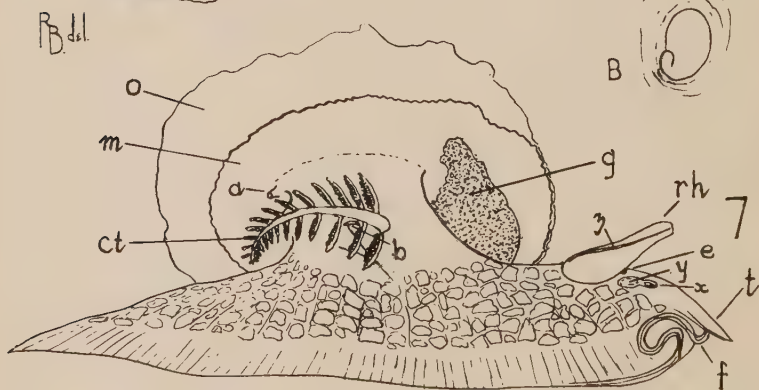
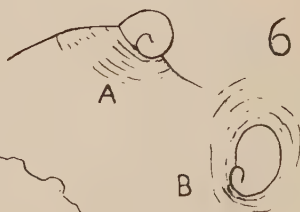
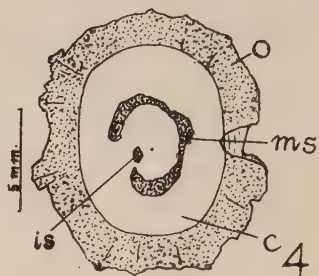
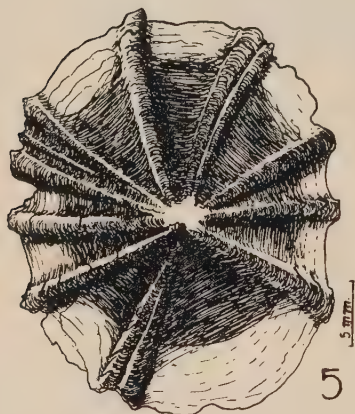
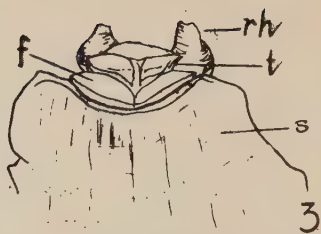
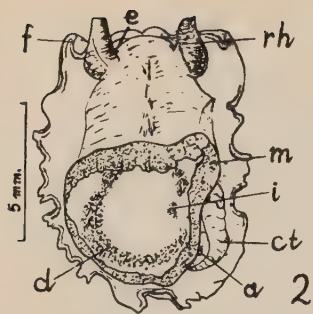


Text fig. 1.

*Tylodina corticalis* (Tate). Photograph of living specimen. (Nat. Mus. Vic.  
No. F21276). (x 2).

cit., p. 65) indicated "about 20 broad rays" on the type. The ridges are dark brown and are hollow on the undersides at the margins, but are built up and filled in before the shell proper is reached. The dorsal sides of the ridges bear a few (3-8) simple spurs or horns representing rest periods during growth. The periostracum contains a number of sand grains in its structural composition; it is pale red-brown in colour. The shell proper shows through the periostracum as an olive-green area; ventrally it is nacreous; within the muscle scars it is yellow; the scars are silver or translucent and the remainder is white. The protoconch (Text fig. 6) comprises  $1\frac{1}{2}$  whorls; it is sinistral, white and entirely smooth; it measures about 0.4 mm. long and 0.25 mm. broad.

The anterior border of the foot is thickened and carries a shallow groove within the thickening; it is notched in the mid-line; the anterior folds (*f*) are characteristic of the species. At the level of the genital apertures the foot turns upwards for a short way, then folds backwards, upwards and forwards until it curls downwards under the oral tentacles. Ventrally, the anterior part of the sole is shallowly concave, and this concavity is filled with the thickened anterior of the foot. The sole of the foot (*s*) is longitudinally striated with shallow muscular furrows. The tail is flat and broadly rounded behind. The foot marginal surface has very low raised lines which radiate out from the body: inside this lined area the skin is raised into low scale-like plates which more or less form lines in conjunction with the marginal raised lines.



Text figs. 2-7.

The mantle (*m*) is thin and tough, with edges thickened and nodular; its surfaces are entirely smooth; Tate (loc. cit., p. 66) records small white carunculae on the underside (these are possibly the result of some infestation of marine parasites). When expanded the mantle reaches to the edge of the periostracum. Contained in the mantle in front of the body is a large chocolate-brown crescent-shaped gland (*g*) which is here termed the pre-mantle gland. The anterior edge of this gland is thick, while near the body it is thin and patchy. No secretions from the gland were observed in the living animals. The rhinophores (*rh*) are large and distinctive; their bases are narrow, as are the tips, while mid-laterally they are swollen and slit (*z*). The eyes (*e*) are black and are situated in front of and between the rhinophores. The oral tentacles (*t*) are short, narrow and latero-ventrally slit; on the median side they meet in a shallow notch between two tumid swellings. The genital apertures are contiguous; the larger female one (*y*) is behind the smaller male one (*x*), and they are situated on the ridge between the rhinophore and oral tentacle on the right side.

The gill (*ct*) is a very elegant plume originating high up under the mantle about half way along the right side of the body. There are twelve alternately placed pinnae each side of the smooth rounded gill rhachis. Each pinna has ten or twelve minute short pairs of whitish feather-like pinnulae. The gill is attached for about half its length; in the larger preserved specimen it is 15 mm. long and is attached for 8 mm.; in the smaller specimen it is 4.2 mm. long and is attached for 1.8 mm. The anus (*a*) opens at the top of a short stout papilla above and behind the junction of the gill attachment and the body wall. Below the anterior of the gill rhachis is a deep cleft or indentation in the body wall, at the anterior top of which is a slit-like opening into a shallow cavity (*b*), the sub-branchial aperture, which is probably analogous with the pre-branchial aperture (of Bourne's gland) of the Pleurobranchacea. The columella muscle (*d*) of the visceral hump shows as a glossy pad around the black viscera, and there is a small flatly triangular intermediate suspensor muscle (*i*) on the right side at the level of the gill. The columellar muscle forms an incomplete ring around the visceral hump, there being a short gap between either end of it and the suspensor muscle (Text fig. 4 *is*, *ms*, and Burn 1959, fig. *d*, both show these gaps between the muscles, but in reverse as the undersides of the shells are figured).

#### Text figs. 2-7.

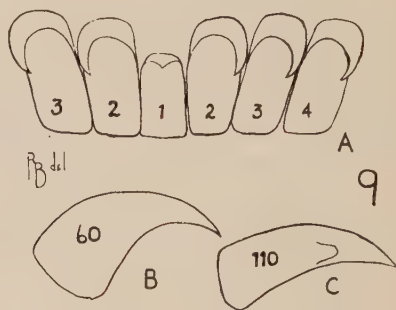
2. Smaller preserved animal from above; shell removed.
3. Anterior part of same specimen as fig. 2 from below.
4. Smaller shell from below.
5. Larger shell from above.
6. Protoconch of Aust. Mus. specimen No. C.62263. A, left lateral side. B, from above.
7. Sketch of living animal from right side.

*a*, anus. *b*, sub-branchial aperture. *c*, shell proper. *ct*, gill. *d*, columellar muscle. *e*, eye. *f*, anterior folds of foot. *g*, pre-mantle gland. *i*, intermediate suspensor muscle. *is*, intermediate suspensor muscle scar. *m*, mantle. *ms*, columellar muscle scar. *o*, epidermis. *rh*, rhinophore. *s*, sole of foot. *t*, oral tentacle. *m*, male aperture. *y*, female aperture. *z*, rhinophoral slit.

The pharyngeal bulb of the smaller specimen only was examined; it measures 3.6 mm. long, 2.4 mm. broad, and 3 mm. high. There is a small, thin jaw plate (Text fig. 8) present in front of the radula measuring 2 mm. in height, the upper pale purple part of which is rounded and fan-shaped with approximately 42 denticulations (muscle hold-fasts) spread evenly along the upper margin. From between these denticulations run shallow furrows in irregular converging courses towards the smooth-edged mouth-opening which is between two thickened purple parts, each with an upper and lower nodular ridge. The radula (Text fig. 9) is pale orange in colour, and is 3.9 mm. long and 1.8 mm. broad; the formula is  $84 \times 130.1.130$ . The rhachidian (1) is smaller than its laterals (2, 3, 4), although there is very little difference in shape. Each tooth has a single cusp with a small flange-like denticle on the inner side which articulates with the cusp of the next. The half rows of teeth meet at the rhachidian in a near straight line, which is as Odhner states for *T. rafinesquei* = *T. citrina* (1939, p. 15).



Text fig. 8.  
Jaw plate.



Text fig. 9. Radular teeth. ( $\times 325$ ).

A. Rhachidian and immediate laterals.  
B. Lateral tooth from outer side.  
C. Outer lateral tooth from inner side.

The genital organs have not been examined.

**Occurrence and Localities:** One specimen (Nat. Mus. Vic. F21275) crawling on weed in a deep rock pool at the outer edge of the reef, Ocean Beach, Flinders, Victoria, 20/3/1960, coll. R. Burn; one specimen (Nat. Mus. Vic. F21276) left on rock platform by receding tide, Ocean Beach, Portsea, Victoria, 3/4/1960, coll. Miss F. V. Murray. Both specimens have been presented to the National Museum of Victoria, Melbourne.

**Discussion:** The known range of *T. corticalis* is from the gulfs of South Australia eastwards through Victoria and northwards to Sydney Harbour, N.S.W. A specimen in the Australian Museum, Sydney (No. C.62263) provides the first record of the species from that State, and also the most northerly record to date. It was "taken alive off Sydney (? Heads) by skin-divers, January, 1957"; no other information is available. The protoconch illustrated in Text fig. 6 is that of this specimen.



That this species is a *Tylodina* is beyond doubt, the examination of the animal validating the author's earlier arguments (Burn 1959, pp. 28-29) for this generic placement. The criteria used by Odhner (1939, pp. 14-15) to differentiate between *Tylodina* Rafinesque, 1819, and *Tylodinella* Mazzei, 1897, when applied to *corticalis* Tate indicate clearly that it belongs to *Tylodina*, and not *Tylodinella*. Briefly these criteria of *Tylodina* are: (1) animal larger than shell and not capable of retraction within it, (2) eyes in front of level of rhinophores and not behind them, (3) presence of rhachidian in radula, and (4) articulation of teeth instead of separation, and (5) presence of an intermediate suspensor muscle between the ends of the columellar muscle.

There are at least three valid species of *Tylodina* throughout the world. They are *T. corticalis* described above, *T. citrina* (Joannis) the type of the genus from western Europe, north-western Africa and the Mediterranean, and *T. fungina* Gabb from California. *T. corticalis* is very similar in the shape of the shell and in the animal to *T. citrina*, but the radial ridges of the periostracum and a different radular formula in the former, appear to separate the two species. *T. fungina* has not been anatomically described to date other than for the figure of the shell muscle scars (Burn 1959, fig. c).

*Tylodina alfredensis* Turton, 1932, from Port Alfred, South Africa, is placed in this genus after examining the muscle scars visible in the type photograph; these scars hardly differ in shape from those of *T. corticalis*, and if the animal could be compared with the present species it might prove to be identical.

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## NOTES AND RECORDS

A Large Specimen of *Notodarus gouldi* (McCoy, 1888).

During a recent trip to the Eyre Peninsula, South Australia, Mr. V. Rogers showed me photographs of himself holding a large squid which he found beached at Fiddlers Bay, some eight miles south of Tumby Bay, in 1956. The squid could be identified as *Notodarus gouldi* (McCoy), or Gould's Calamary. Unfortunately, the tentacles were missing, most likely having been torn off by birds, but the remainder showed that the animal was very large, in life probably being over four feet long. This is about twice the normal length of the species, and would be the largest specimen yet recorded from South Australia.

—B. C. Cotton, South Australian Museum.

Notes on *Zoila thersites* (Gaskoin, 1849).

A well developed ledge (expanded base) is a common character of all shells taken from the Sir Joseph Banks Group, Spencer's Gulf, South Australia. In a series in the South Australian Museum from other localities, some specimens show a slight development of this ledge, thus indicating that those from the Sir Joseph Banks Group represent an ectotype rather than a distinct variety.

During a recent search in this area, Mr. Alan Rogers brought to the surface a fine specimen of *Z. thersites*, with its mantle extended over the edges of a single valve of a Queen Scallop, *Equichlamys bifrons*, in which it had spawned. The egg capsules, deposited in a gelatinous mass, were golden yellow in colour, round and about 5 mm. in diameter. Several juveniles in the bulla stage were observed during the year, the animals of which were a bright saffron yellow, contrasting with the black of the adult.

—W. P. Trenberth, Tumby Bay, South Australia.

Recently I saw a very fine range of *Zoila thersites* taken from the Gulf of St. Vincent side of Yorke Peninsula, South Australia, and noticed that they were definitely smaller than those from the Sir Joseph Banks Group, on the other side of the Peninsula in Spencer's Gulf; also in general colour they were a deeper shade of brown. All were inhabiting approximately the same depth of water—about 12 to 25 feet according to the tide at the time of taking.

—R. A. Hall, Prospect, South Australia.

New Names for two Victorian Opisthobranch Molluscs.

1. The name *Melibe pellucida* Burn, 1957, *J. malac. Soc. Aust.*, 1: 24, has been found to be preoccupied by *M. pellucida* Bergh, 1904, which is synonymous with *M. leonina* (Gould, 1853) from the Atlantic coast of North America, therefore the name *M. maugeana* is now proposed for the Victorian species in place of the homonym.

2. *Cyerce nigra pallens* Burn, 1957, *J. malac. Soc. Aust.*, 1: 14, proves not to be a *Cyerce* Bergh, 1871 (= *Lobifera* Pease, 1866, vide Pruvot-Fol, 1947, *J. Conchyliol.*, 87 (3): 100-104) since it does not have the transversely divided foot of the genus. The Victorian species is probably a *Branchophyllum* Pruvot-Fol (loc. cit.), although this genus has an entire but very much narrower foot than the present species. Nevertheless it is better to place the species in this genus, and it will now be known as *Branchophyllum pallens* (Burn).

—R. Burn, Geelong West, Victoria.

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"Easy reading's curst hard writing."—*The Editors, J. gen. Microbiol.*





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